WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

E. A. BIRGE, Director. W. O. HOTCHKISS, State Geologist.
A. R. WHITSON, In Charge, Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
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RECONNOISSANCE SOIL SURVEY

OF

SOUTH PART

OF

NORTH CENTRAL WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, T. J. DUNNEWALD AND
CLINTON B. POST

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

ARTHUR E. TAYLOR, J. B. R. DICKEY AND CARL THOMPSON

OF THE

U. S. DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES
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MILTON WHITNEY, CHIEF
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* Scientist in Soil Survey, In charge of field operations in Wisconsin for the Bureau of Soils, U. S. Department of Agriculture.

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NOTE

The soil survey of Wisconsin is being made along two lines; first a general survey of the northern and less-developed portions of the State, and second a detailed survey by counties of the southern and older portions. The northern part of the State has been divided into five areas of each of which a general map of the soils is being prepared.

The first area surveyed included Portage, Wood, Clark, Taylor, Lincoln, Marathon, and portions of Price and Langlade Counties. The first survey of the soils of this area was made a number of years ago by Doctor Samuel Weidman in connection with the geological survey, and the classification followed in this work differed somewhat from that at present in use, and the maps do not show as much detail. The reports of this survey are no longer available.

An entirely new survey has been made of this area, and the new report and map covering Clark, Taylor, Lincoln, and Marathon Counties are included under this cover. This area is now known as the South Part of North Central Wisconsin.

Wood and Portage Counties have been surveyed in detail and separate reports and maps are now available for each of these counties.

The second area, called the South Part of North Western Wisconsin, included Polk, Barron, most of Rusk, and all of Chippewa, Dunn, St. Croix, Pierce, Pepin, and Eau Claire Counties. The edition of this report has been exhausted.

The third area, called the North Part of North Western Wisconsin, included Burnett, Washburn, Sawyer, Douglas, and Bayfield counties, and most of Ashland County. The reports on this area are so nearly exhausted that it is only possible to loan copies for a short time.

A special report has been prepared on the northeastern portion of Bayfield County along the bay and including the islands, in which considerable development of the fruit industry is taking place. This is now available for distribution.

The fourth area called North Eastern Wisconsin includes

Florence, Forest, Langlade, Oconto, Marinette, and Shawano Counties. The report on this area is now available.

The fifth area, called the North Part of North Central Wisconsin, includes Iron, Vilas, Price, and Oneida Counties and the eastern portions of Ashland and Rusk Counties. Reports on this area are now available.

A special report on the soils of Vilas County and portions of adjoining counties was prepared during the season of 1914 at the request of the Legislature when that body was considering the extent to which the development of forest reserve should be carried. Mr. T. J. Dunnewald was in charge of the field work of this survey. The map accompanying this report is included in the report on the soils of the North Part of North Central Wisconsin as well as the more important portions of the report itself, but copies of the special report and map are still available.

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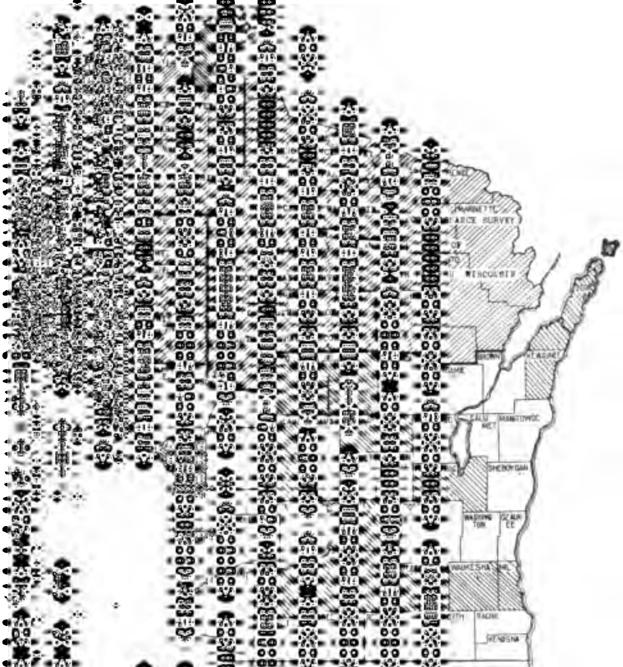

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Topographic Features.—Within the region covered by this report there are two distinct types of topography. The portion of the area covered by the late Wisconsin Ice Sheet and occupying most of Taylor, Lincoln, and the eastern portion of Marathon Counties is characteristic of a glacial region. The surface varies from level to rolling and hilly, and there are numerous marshes, lakes and kettle holes. The most prominent feature of this Late Wisconsin Drift region is the broad and very broken belt of terminal moraine which extends across Taylor, Lincoln and eastern Marathon counties.

The portion of the area lying south of the terminal moraine may be divided into two sections—first that which is spoken of as the unglaciated region in central Marathon County, and second that which lies to the west in western Marathon and most of Clark Counties. Throughout this unglaciated region and also throughout the region of old glaciation to the west the surface consists chiefly of a broadly rolling country where the hill tops are rounded and the slopes are rather gentle. There are but few lakes and swamps.

Other conspicuous features of the topography are Rib Hill which is located about two miles to the southwest of Wausau. and the terrace formation along the Wisconsin River and its tributaries.

Rib Hill, about two miles to the southwest of Wausau is reputed to be the highest point in the state and has an elevation above sea level of 1940 feet. The water in the Black River below Dells Dam at a point three miles north of the south line of Clark County has an elevation of 784 feet, and this is about the lowest point in the county. It will thus be seen that there is an extreme difference of about 1000 feet in the elevation of the varions portions of the survey, though the major portion of the region will range from 1000 to 1600 feet above sea level.

Water Power.—Practically all of the streams in the area are swift flowing, and immense amounts of water power are available. Extensive water power developments have been made at Tomahawk, Merrill, Wausau, Schofield, Mosinee, and at several other points, but only a comparatively small proportion of the available water power has been developed. The elevation of the water in the Wisconsin River above the Tomahawk dam is 1,431 feet. The elevation near Dancy where the Little Eau Plaine joins the Wisconsin is 1,089 feet, so it is seen that between these

two points there is a fall of 342 feet in the Wisconsin River. The fall in the other rivers of the area is at about the same rate.

Settlement and Early History.—The first line of activity developed in the region covered by the present survey was by the American Fur Company which had a number of agents scattered through this section. Settlers who came into the region with the idea of locating did not appear until about 1840. During this year there was a small mill established at Big Bull Falls on the Wisconsin River. The first industry was, of course, the cutting of the pine timber, and for many years, lumbering was the most important industry followed.

In the early development of this region practically all the transportation was by boat on the Wisconsin and other large rivers. The first railroad was the Wisconsin Central which was completed through the area in 1873. In 1874 what is now the Chicago, Milwaukee & St. Paul was built to Wausau and extended to Merrill in 1881.

In 1855 the German immigrants started to come into the region, and agricultural development may be said to date from about this time, although the land actually placed under cultivation at that early date was very small. At present a large proportion of the population is German or of German descent, though most of these are probably American born. Quite extensive settlements of Scandinavians were also made at an early date, and of later years numerous Poles, Finlanders and other foreigners have taken up land in these counties. A considerable proportion of the inhabitants have also come from the southern counties and from other states.

Marathon and Clark counties were the first to be settled, and now a large part of the best land in these counties is improved and highly developed. In Lincoln and Taylor Counties there are still extensive areas of unimproved land, most of it being cut over, still there are large tracts of virgin forest in some sections. In these two counties the population is rather unevenly distributed, there being some townships in which practically no roads or settlers are found. The census of 1910 gave Marathon County a population of 55,054, Clark County 30,074, Lincoln County 19,064, and Taylor County 13,671, giving a total population of 117,833.

Chief Towns—Wausau, the largest city and the county seat of Marathon county has a population of 16,560. Merrill, the

next city in size is the county seat of Lincoln County and has a population of 8,689. Medford, the county seat of Taylor County, has a population of 2,050, and Neillsville, the county seat of Clark County has a population of 1,957. Tomahawk in the northern part of Lincoln County has a ppoulation of 2,626. In 1910 there were only three cities in the area having a population of over 2,500, so that it is seen that by far the greater proportion of the population is rural, although there are very many small towns with populations of from 300 to 1,200.

Transportation Facilities.—Nearly all portions of the area surveyed are well supplied with railroad facilities. Lines belonging to three of the largest railway companies in the state traverse the area. These are the Chicago, Milwaukee & St. Paul, the Minneapolis, St. Paul & Saulte Ste. Marie, and the Chicago and Northwestern.

Markets.—The cities and logging camps within the area surveyed afford a market for a considerable portion of farm produce. A larger proportion, however, is shipped to outside points. Dairy products probably make up the largest proportion of the output of the farms, and butter and cheese are shipped to markets in various parts of the country, much of it, however, passing through Chicago firms. Quantities of hay are shipped to Milwaukee and other points, and the shipping facilities are such that excellent markets are within easy access of all portions of the region covered by this survey.

Public roads and Schools.—The wagon roads throughout the settled portions of the area are usually in fair condition. Many of the main roads have been improved under the new state highway improvement law, and these are all in excellent condition, having been crowned with gravel or crushed rock. Where the country is nearly level and the drainage somewhat poor, the side roads are sometimes in rather poor condition, and in the spring when the frost is coming out of the ground they are at times nearly impassable. When the roads have dried, they are in very good condition.

The rural school buildings throughout the area will average somewhat better than through the southern part of the state. In some sections several districts have been combined and the children are all carried to and from school in a public conveyance. Rural free delivery routes reach nearly all of the people. The rural telephone is in common use and many of the farms are furnished with this convenience.

ORIGIN AND GENERAL NATURE OF SOILS †

Most of this region, in common with all of northern and eastern Wisconsin, owes the general character of its surface to glacial action. Two very distinct periods of glaciation occur. The older drift*, which was probably deposited by three separate ice sheets, is confined largely to Clark and Marathon Counties. One of the most important characteristics of this old drift formation is the compact character of the subsoil, and the comparatively level or gently rolling nature of the surface.

In the central portion of Marathon County there is a considerable area which is usually spoken of as an unglaciated region and in which the soils are largely of residual origin. Over this section, however, it is not uncommon to find a few glacial boulders and other evidences which indicate that this region was influenced to a very slight extent by glacial action. Throughout this region as well as throughout the region of the old drift sheets there are but few marshes and lakes, the topography is level to gently rolling, and in places the natural drainage is deficient.

The material which was deposited by the Late Wisconsin Ice Sheet occupies the greater portion of Taylor, Lincoln, and † eastern and southeastern portions of Marathon Counties. For the most part the topography throughout this region is more or less rolling and hilly and much more irregular than in the region of the older glacial drift. Lakes, swamps, kettle holes, and sharp ridges are common, and the stream channels have not been as well established as in the older sections. The soils are of a much more variable character than is the case of the old drift regions, and stones and bowlders are much more plentiful.

The glacial drift has been derived largely from the underlying geological formations of which several are represented. Throughout Lincoln, Taylor and most of Marathon and along the eastern and northern sides of Clark County, crystalline rocks, chiefly granites and dark colored rocks make up the underlying formation, so that most of the soils of the area have been derived largely

† As this report is intended chiefly for agricultural readers no attempt is made except in a very general way to discuss the Geology of the region.

* See Weidman —"Geology of North Central Wisconsin."

from granitic rocks. On Rib Hill and on Mosinee Hill quartzite is the surface rock. Throughout the greater part of Clark County and over isolated areas in Marathon and Taylor Counties, Potsdam sandstone forms the surface rock. Over most of Clark County, however, this formation has been covered by early glacial material from the north and so has not contributed very extensively to the soil formation in such places. The sandy soils in southern and western Clark County have been derived largely from this Potsdam sandstone.

In the survey of this area the soils have been classified into twelve series and thirty soil types, all of which have certain characteristics by which they can be readily recognized.

The Colby series is the most extensive and includes light colored upland timbered soils in the glaciated region where the underlying material is extremely compact and usually heavy. The subsoil and sometimes the surface soil is mottled to a marked degree. Due to the rather level surface and the heavy character of the subsoil the natural drainage is often deficient, and the internal drainage is nearly always deficient. Only one type, the Colby silt, loam was mapped.

The Kennan series includes light colored upland soils in the glaciated region where the material has been derived largely from the underlying crystalline rocks. The surface soil is predominatingly heavy and the subsoil is quite gravelly and porous. The types mapped belonging to this series are the silt loam, loam and fine sandy loam.

The Vilas series embraces all glacial soils which have been derived largely from crystalline rocks and which are lighter in texture than a fine sandy loam. Four types, the sandy loam, fine sand, sand and gravelly sand were mapped.

The Marathon series includes light colored upland timbered soils in the crystalline rock region where the material, especially the subsoil, is largely of residual origin. The silt loam, gravelly silt loam, fine sandy loam and sandy loam were mapped as belonging to this series.

The Antigo series includes light colored timbered soils of alluvial origin where the material has been deposited in the form of outwash plains, stream terraces, or filled in valleys. The upland material has come from the crystalline rock formation and in some instances there has been incorporated with this a small

amount of material from sandstone rocks. Only two types of this series, the silt loam and fine sandy loam were recognized.

The Plainfield series includes light colored soils of alluvial origin which have been deposited as outwash plains, stream terraces, or filled in valleys. The upland matrial has come entirely or nearly so from sandstone, and in this respect differs from the Antigo series. The types of this series are sandy loam, fine sand, sand and gravelly sand.

The Knox series which is of very small extent consists of light colored upland soils in the unglaciated region where the soil has been derived largely from loessial material. Only one type, the silt loam, was mapped.

The Vesper series consists of light colored material where the subsoils have been derived largely from the weathering of sandstone, while the surface material consists chiefly of a loess-like deposit which is very high in silt and clay. The characteristic feature of this series is that the surface soils are heavy, while the underlying material is sand or sandstone rock. Only one type, the silt loam was recognized.

The Boone series consists of light colored unpland timbered soils in the unglaciated region where the material has been derived largely from the wearthing of the Potsdam sandstone. The fine sand only was mapped.

The Auburn series includes light colored upland soils where the material composing the subsoil is largely residual from sandstone, and in places from shale associated with the sandstone. The soil is in part loessial and in part from Pre-Wisconsin glacial material. These materials have become intermixed in places so that a considerable range in texture is found. Auburn loam and fine sandy loam were mapped in this survey.

The Whitman series consists of dark brown to black low-lying material which has been derived largely from crystalline rocks. In physiographic position it is comparable to the Clyde soils and may be largely alluvial or it may occur as poorly drained depressions or old lake beds. The silt loam was the only type mapped in this series.

The Genesee series consists of light colored timbered soils of alluvial origin largely within the glaciated region. It is seldom that material lighter in texture than a fine sandy loam occurs in this series, however, a small area of sand was mapped.

The Dunning series consists of dark colored low-lying light

textured soils in non-calcareous regions. In most cases the material has been derived from the underlying sandstone. In the surface there is usually an accumulation of varying amounts of organic matter which gives the dark color. Its position is comparable to that of the Clyde, but it differs in that both soil and subsoil show varying degrees of acidity. The fine sand is the only type mapped of this series.

The peat mapped in this area consists of decaying vegetable matter in varying stages of decomposition. A large proportion of it is of a brownish color and quite raw and fibrous.

The following table gives the name and actual and relative extent of each soil type mapped.

Area of Different Soils.

Soil	Acres	Per cent
Colby silt loam	556,928	44.8
Rolling phase	779,968	
Kennan silt loam	169,856	8.1
Rolling phase	68,992	
Kennan fine sandy loam, rolling phase	264,512	8.8
Marathon silt loam	188,160	6.2
Peat	142,848	5.4
Shallow phase	17,216	
Auburn fine sandy loam	71,040	2.4
Whitman silt loam	96,256	3.2
Auburn loam	76,608	2.6
Marathon fine sandy loam	70,656	2.4
Vesper fine sandy loam	68,544	2.3
Vilas fine sand	54,080	1.8
Boone fine sand	46,208	1.5
Plainfield sand	44,928	1.5
Antigo silt loam	36,160	1.2
Genesee silt loam	35,008	1.2
Plainfield gravelly sand	30,208	1.0
Vilas gravelly sandy loam	22,656	.7
Plainfield fine sand	22,464	.7
Colby loam	20,416	.7
Dunning fine sand	18,944	.6
Antigo fine sandy loam	18,880	.6
Vilas sandy loam	5,824	.2
Vesper silt loam	14,336	.5
Marathon sandy loam	12,800	.4
Plainfield sandy loam	10,752	.4
Marathon gravelly silt loam	5,632	.2
Genesee sand	6,208	.2
Knox silt loam	4,864	.2
Rough stony land	2,240	.1
Vilas sand	1,408	.1
Total	2,985,600	....

SOIL CLASSIFICATION

Many of the most important qualities of the soil depend on the relative amounts of different sized grains present in the soil. This is called the *texture* of the soil. In order to classify soils it is therefore necessary to determine the relative proportion of the soil made up of each of the different sized grains. This separation of the soil is called *mechanical analysis* and in the system most commonly used seven different sizes of grains are recognized and named as follows: fine gravel, coarse sand, medium sand, fine sand, very fine sand, silt and clay. Practically all soils have at least a small amount of each of these different sizes. The following table gives the average texture of the most important classes of soils:

Average Texture of Important Classes of Soils.

Class of Soil	Mechanical analysis giving average percentage of soil separates in each class.						
	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Medium sand soil ..	3	14	20	38	12	8	5
Fine sand soil	0	2	14	49	20	11	5
Sandy loam soil ..	5	10	10	25	15	20	15
Fine sandy loam soil	1	4	5	20	25	30	15
Loam soil	1	3	4	15	20	40	17
Silt loam soil	1	1	2	6	10	60	20
Clay loam soil	0	1	2	5	15	42	35
Clay soil	0	1	2	5	12	30	50

Soils, of course, vary in many other respects than texture, due to their origin. This affects the topography or lay of the land, drainage conditions, and chemical composition including the amount of organic matter. All of these factors are included in the series to which proper names have been given. The Kennan series, for instance, as mapped in this area, includes three types differing in textures but all of which were formed by glacial action on granitic rocks and are low in organic matter and undulating to rough in topography. Each of the other series, such as the Colby, Vilas, etc., have similar characteristics which are described in the following pages.

For convenience in discussing their agricultural value and management the 30 types of soil are classified into five groups—(1) a group of heavy soils, (2) a group of merium heavy soils, (3) a group of medium sandy soils, (4) a group of sand soils, and (5) a group of poorly drained soils.

CHAPTER II

GROUP OF HEAVY SOILS

Colby Silt Loam

Extent and distribution. The Colby silt loam, including the rolling phase, is the most extensive type of soil within the region surveyed, covering a total area of more than 2000 square miles. It is found in all four of the counties, but is most extensively developed in Marathon and Clark Counties. It is found in all portions of Clark County except along the western and southern borders. In Marathon County its greatest extent is in the western and northern portions of the county. In Taylor County it occurs in the western and northwestern parts and also in the southern and southeastern sections, especially in the vicinity of Medford. In Lincoln County it is confined chiefly to the western and southwestern parts. Throughout its entire extent it is closely associated with the rolling phase and the line between the typical soil and this phase is an arbitrary one and often difficult to establish because of the gradual change from one class of topography to the other.

Description. The surface soil of the Colby silt loam to an average depth of about 10 inches consists of a heavy gray or grayish brown silt loam which has a very smooth velvety feel due to the presence of a very large amount of silt. When this soil is dry it has a gray ashen appearance. In some cases the surface has a larger accumulation of organic matter than typical and in such places the soil is brown or dark brown in color. In some instances the lower portion of the soil section is slightly mottled.

The subsoil of this type consists of a heavy silt loam of a grayish or yellowish color which gradually becomes heavier with depth, grading into a silty clay loam or clay loam at about 14 or 16 inches below the surface. This heavy material which is extremely compact extends to a depth of about 30 or 36 inches where it is common to find varying amounts of fine and medium

sand and sometimes angular or rounded gravel mixed with the material. This gritty clay loam, as it may be called, frequently extends to great depth, though the underlying rock may be found at a depth of 4 feet or more. The most characteristic feature of the subsoil is the fact that it is strongly mottled. Colorings of yellow, blue, gray, red, and rusty brown are very common. In a number of instances the deep subsoil was found to consist of a red clay, and a reddish cast is frequently found to prevail through a large portion of the soil section. The structure of the subsoil of this type is rather peculiar. The proportions of silt and clay to the amounts of coarses material are such that it is very impervious to the passage of water and when dry it appears to be sufficiently elastic so that it does not crack as is the case with many heavy clay soils. This peculiarity makes the type more difficult to handle than many soils having as much or more silty and clay material present.

As a type the texture, structure, and color of the soil are remarkably uniform. There are a few variations, however, chiefly in regard to its depth, which are worthy of note. In a few instances it was found that sandstone rock was encountered in the subsoil at a depth of from 18 inches to 3 feet. In some sections this sandstone had weathered into a sand and in some cuts it was noticed that this material outcropped. Wherever this condition was found to prevail over tracts sufficiently large to map, the material was classed as Vesper silt loam. There are a number of instances, however, where the areas were of very small extent and could not be indicated on a general soil map. Some stones may be found upon the surface but never in such numbers as on the Kennan silt loam. Large tracts are free from stones or nearly so.

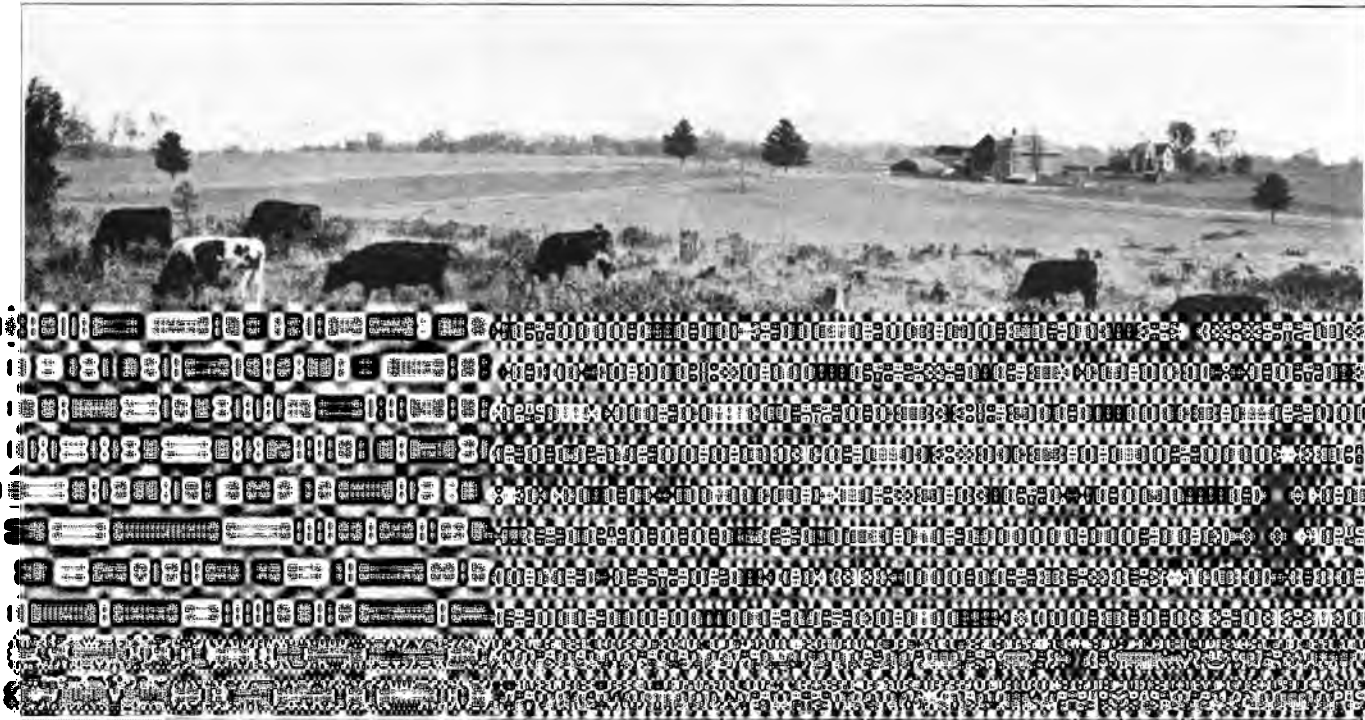
In Marathon County to the east and northeast of Wausau and immediately south of Glandon there is considerable land mapped as Colby silt loam but which differs from that in being within the unglaciated region, the subsoil is largely residual, and stones are very scarce. The subsoil, however, is mottled and impervious making the drainage conditions similar to those of the Colby silt loam.

Topography and drainage. The surface of the Colby silt loam is level or very gently undulating and because of the surface features and the extremely heavy character of the soil and subsoil the natural surface and under drainage are both quite deficient.

Wherever the slope was sufficient so that the surface drainage conditions were considered fair to good the type was classed with the rolling phase. Over some of the lower places where the surface is level over large tracts a semi-marshy condition prevails where the land has not been cleared and placed under cultivation. In spring and early summer a few inches of water sometimes stands in such places for a considerable period of time. In a few instances a sufficient amount of organic matter has accumulated to give the soil a rather dark color and where this condition is the most pronounced the material has been mapped with the Whitman series. When these flat semi-marsh tracts are cleared and placed under cultivation the drainage conditions improve to a marked degree even without the installation of extensive drainage systems. The type as a whole, however, is cold and backward in the spring and the planting of crops is frequently delayed because of the soggy condition of the land.

Origin. The material forming the Colby silt loam is derived from at least two sources and probably three. The greater part of the type lies within the section which was traversed by the Pre-Wisconsn ice sheets and some of the material was brought to its present position through the action of one or more glaciers. The underlying rock throughout this region consists of crystalline material—largely granite, and it is from this source that most of the material came. The extremely silty surface appears to be partly of loessial origin and forms an extensive blanket over a large amount of north central Wisconsin. In a number of cases the deep subsoil appears to be partly residual, having been derived directly through the weathering of the underlying rock. The portions of the type which occur in northern Taylor and northwestern Lincoln Counties lie within the belt of country traversed by the Late Wisconsin Ice Sheet and may have been influenced to a limited extent by this last period of glaciation, though it seems probable that most of the material of glacial origin was deposited by earlier ice sheets. There is no limestone rock in the region covered by the present survey and varying degrees of acidity have developed in both soil and subsoil; in many cases an extremely acid condition prevails, while in other cases the acidity is only slight.

Native vegetation. The original timber growth on the Colby silt loam consisted chiefly of hardwood, white pine and hemlock. Of the hardwoods maple, birch, basswood, elm, and ash, and



sometimes oak, were found—the ash and elm being confined to the sections which were most poorly drained. Scattered throughout the hardwood white and Norway pine were found. In a number of instances large tracts were found over which the predominant growth was pine. In other sections the hardwood was most plentiful and the pine was almost entirely lacking. All of the pine has been removed, but large tracts of hardwood and hemlock still remain. Over the cut-over land which has not been improved there is often a rather dense second growth of popple and birch.

Present agricultural development. While a considerable amount of the Colby silt loam is now under cultivation, there are also extensive areas which have not been cleared. The type is naturally a productive soil and its virgin fertility may be considered fair to good. The greatest difficulty in its development is the question of drainage and the poor drainage conditions which prevail have retarded the development of this class of land. The chief type of agriculture which is followed consists of general farming and dairying to which the land is well adapted. This soil is especially well adapted to grasses, and it always supplies excellent grazing. Because of the fertile condition of the virgin soil clover usually does very well on new land in spite of the fact that the soil is usually strongly acid. After the land has been cultivated for a number of years and some of this fertility removed there seems to be more difficulty in growing clover successfully. Timothy and alsike clover grow very well, but alfalfa cannot be grown successfully without the use of some form of lime. Small grains such as oats and barley give very satisfactory yields when fair drainage is supplied. Corn is grown, and with drainage fair yields are secured. The crop can usually be matured, though it may sometimes be damaged by early fall frosts. It can always be matured sufficiently for silage. In the improvement of this soil there are two points which should be given careful consideration. The first is that of thorough drainage and the second is that of thorough cultivation. The surface drainage may be greatly improved by plowing fields in narrow strips having dead furrows at intervals of every 2 or 3 rods and running with the slope. These may connect along the margins of the field with open ditches which will supply an outlet. This type of drainage is often sufficient so that all kinds of crops common to the region can be successfully grown and while the

land is new and the amount of capital available somewhat limited, this may be considered as probably the best system to install.

Tile drainage on this soil is less effective than on most other heavy soils of the state, because of the heavy impervious nature of the subsoil. In most cases it is necessary that tile should be placed from 3 to 4 rods apart, which makes the tiling of this soil expensive. However, experiments have shown that for certain crops such as potatoes and corn, this expense for thorough tile drainage is a good profitable investment, so that farmers having this class of land could well afford to plan on draining a portion of their farm, leaving the remainder for those crops which do not require such thorough drainage.

Cultivation of this soil is not difficult and as soon as moisture conditions permit getting on the land a good mellow seed bed can be secured readily.

A rotation of crops which appears to be well suited to this land consists of small grains with which clover and timothy may be seeded and hay cut for two years after which the land may be plowed for corn to be followed again by small grain crops.

Most of the general farm crops, with the exception of clover and alfalfa, make good growths on this acid soil and such legumes as soybeans and serradella can be grown successfully under acid conditions so that it is possible to carry on a system of farming without the use of lime.

However, as this soil is kept under continual cultivation and the fertility is somewhat reduced, the need for the use of lime will gradually become apparent, so that ultimately it will be found profitable for farmers on this soil to lime the greater part of their land for the growth of the general farm crops, as well as for the best growth of clover and alfalfa.*

COLBY SILT LOAM—ROLLING PHASE

Extent and distribution. The rolling phase of the Colby silt loam is very closely associated with the typical soil and is confined to approximately the same portions of the area. The largest tracts occur in western and northern Marathon County,

*For a discussion of the chemical composition and improvement of this soil see page 40.

southern and western Lincoln County, throughout Clark County with the exception of the western and southwestern portions, and throughout the eastern and southeastern portions of Taylor County. There are also a few small areas in the northwestern portion of Taylor County in the vicinity of Jump River. This phase differs from the level Colby soil chiefly in topography and as the change from one to the other is often very gradual the line separating them is usually an arbitrary one. Small tracts of the level soil are often included with the rolling phase and the converse is also true in many cases.

Description. The rolling phase of the Colby silt loam to an average depth of 8 or 10 inches consists of a heavy gray or grayish brown silt loam which has an extremely smooth feel. The content of silt is extremely high, but the amount of organic matter present is rather low. When the soil is dry it has a gray ashen appearance, but this color gradually becomes darker with an increased moisture content. Where there are accumulations of organic matter, which is frequently the case in low-lying places, the color is frequently a dark brown. The subsoil of this phase consists of a heavy silt loam of a grayish or yellowish color which grades into a silty clay loam or clay loam at about 14 inches. This heavy compact material extends to a depth of about 30 inches where it is common to find incorporated with it varying amounts of medium sand and fine angular or rounded gravel which gives it a gritty feel. This gritty material usually extends to a great depth, though in a few cases the underlying rock was found within 4 or 5 feet of the surface. Both soil and subsoil of this phase are extremely uniform and in texture, color, and structure the phase is very similar to the typical soil. It differs somewhat in that the lower portion of the subsoil is seldom mottled and the upper portion of the subsoil is not as strongly mottled as the typical soil, but in the lower depth the mottling is practically the same and is usually quite pronounced. As in the typical soil a heavy red clay is sometimes found in the lower subsoil and a reddish cast frequently prevails throughout the subsoil section. The peculiar structure which is characteristic of the level Colby soil is also characteristic of this phase, but it is not so objectionable in this case because of the more uneven character of the surface.

In a very few instances it was found that small areas of this

phase were underlain by Potsdam sandstone which sometimes came within reach of the auger and in road cuts fragments of sandstone rock were sometimes seen; such areas, however, were of limited extent and seldom of sufficient size to be indicated. The underlying formation throughout this region is almost entirely of crystalline rocks.

Some stones and a few boulders are frequently found scattered over the surface of this phase, though they are seldom present in sufficient amounts to interfere with the cultivation of the soil. These stones are usually rounded, indicating glacial origin, though along the border of the phase adjacent to the soils of the Marathon series there are frequently some angular pieces of rock found upon the surface. In no place over this soil are the stones as plentiful as on the soils of the Kennan series. Many extensive tracts are practically stone-free.

Topography and drainage. The surface of the rolling phase of the Colby silt loam varies from very gently rolling to rolling. The type always has a more pronounced slope than the level phase and was separated on this basis. There is always sufficient slope so that surface water will be readily carried off. Because of this difference the phase has a somewhat higher agricultural value. In spite of the fact that the surface drainage of this phase is fair to good, the heavy character of the subsoil makes the movement of water through the soil very sluggish so that in low places between slopes and even on some of the slopes themselves the installation of tile drains will doubtless be found profitable.

Origin. The material forming the rolling phase of the Colby silt loam has practically the same origin as the level soil, having been derived in part through glacial action and in part from the deposition of loess-like material. The deep subsoil may also be in part residual, having been derived in part from the underlying crystalline rocks. As there is no limestone in this section an acid condition has developed in both soil and subsoil and this is frequently very marked.

Native vegetation. The original timber growth on the phase is very similar to that found on the typical soil, except that there is a smaller amount of elm and ash, since these trees are found more extensively on the poorly drained land. Maple and birch formed the greater part of the original growth, but there

was also considerable hemlock and over some tracts white pine was the predominant growth. Over the northermost portion of the type there is still a heavy forest growth. Where the land has been cut over and not improved or grazed there is often a second growth of popple and birch springing up.

Present agricultural value. A larger proportion of the phase is under cultivation and more highly improved than is the case with the level soil. This is probably due to the fact that it has better drainage, it can be worked earlier in the spring, and better yields can usually be secured. This is a very good general farming soil and the dairy industry is highly developed upon it. It is naturally a productive soil and its virgin fertility may be considered good. It is especially well adapted to grasses, and clover makes an excellent growth on new land even though the soil is acid. After fields have been cultivated for a number of years the clover does not make quite as good a growth as at first, so that liming may ultimately be necessary.

The chief crops grown consist of timothy and clover, oats, barley, a small amount of wheat, corn, and potatoes. The small grains do very well on this soil, and corn also makes a very satisfactory growth, though there is some danger of early fall frosts.*

Kennan Silt Loam

Extent and distribution. The Kennan silt loam is one of the important soil types of the region surveyed, from the standpoint of its agricultural possibilities, though in area it is not as extensive as several other types of soil. The most extensive tracts of the typical soil occur in eastern Marathon County, and western, central, and southeastern Lincoln County, smaller tracts are also found in various parts of Taylor County, and in the extreme northwestern corner of Clark County.†

Description.—The surface soil of the Kennan silt loam to an average depth of 10 inches consists of a brown or grayish-brown friable silt loam in the surface few inches of which there is sufficient organic matter to impart a dark brown color to the virgin

*For a discussion of the chemical composition and improvement of this soil see page 40.

† The area of Marathon silt loam along Pine river due east from Merrill should have been included with the Kennan silt loam.

soil. The subsoil consists of a yellow or light yellowish-brown silt loam which usually becomes somewhat heavier with depth until a depth of from 20 to 30 inches is reached where a lighter textured material is encountered. This may consist of a fine sandy loam, sandy loam, or a sandy clay loam, with which there is usually varying amounts of small gravel stones. The line between the silty covering and the coarser textured subsoil is usually quite sharp, and in cuts the abrupt change can be readily seen. The surface material is comparatively free from gravel, while in the deep subsoil it is quite plentiful. Bowlders accur upon the surface in a rather irregular manner, there being numerous areas which are stone free. It is seldom that stones and bowlders are ever sufficiently numerous over any extensive tract to retard or discourage agricultural development.

Some variations occur in this type, chiefly in the depth of the silty covering over the coarser textured material. In a few instances the underlying sandy material outcrops or comes to within several inches of the surface, while in other sections the silty covering extends to a depth of over 3 feet. Small areas of fine sandy loam were sometimes included with this soil, but because of the small extent of all of these variations they could not be indicated separately on a general soil map.

This soil works up readily when placed under cultivation and no difficulty is experienced in securing a good seed bed.

Topography and drainage.—The surface of this type ranges from undulating to gently rolling. In some portions of Lincoln County some tracts which were rolling were included with the type. Because of the usual surface features and the underlying coarse material the natural surface and under drainage are good. Peat marshes are quite commonly found associated with this soil along the borders of some of these where the surface is nearly level, and low, the natural drainage is sometimes deficient, but such conditions cover comparatively small areas.

Origin.—The material forming the Kennan silt loam appears to have been derived from two distinct sources. The underlying material has doubtless come from the underlying crystalline rocks through the action of glacial ice, in some places the subsoil appears to be residual from the underlying rocks. The surface silty covering appears to be in part at least of loesial origin, forming a part of an extensive silty loess-like blanket which covers very extensive areas in northcentral Wisconsin.

There is no limestone present in this region, and an acid condition has developed in both soil and subsoil.

Native vegetation.—The native timber growth on this soil consisted of maple, birch, hemlock, with smaller amounts of basswood, oak and a little elm. Mixed with the hardwood there are also varying amounts of white and some Norway pine. All of the pine has been cut but there is still considerable hardwood and hemlock standing. Where the land has been cut over the present growth consists chiefly of popple and birch brush.

Present agricultural development.—Only a comparatively small percentage of this type is cleared and under cultivation, but with its rolling phase, it gives promise of becoming one of the most highly improved soils in the area. Much of this land is still owned in large tracts by lumbering companies and individuals, and its development along the line of agriculture is thus somewhat retarded. Regions where development has taken place on this soil are found north of Hatley, and to the north and south of Norrie in eastern Marathon County, east of Merrill and in the vicinity of Irma in Lincoln County. In Taylor County there is a considerable settlement on the rolling phase in the vicinity of Lublin.

The chief crops grown are hay, oats, potatoes, corn, and various root crops. Potatoes do very well and seem to be especially suited to the soil and climate. Yields range from 150 to 200 bushels per acre, and often higher. Oats yield about 50 bushels and hay from 2 to 3 tons per acre. Clover and all kinds of grasses suited to the climate do remarkably well, and along old tote roads, and about all the old lumber camps there is always a rank growth of clover and grasses. Peas are grown to some extent and give good yields. Barley, wheat and sugar beets thrive but are not grown to any extent in this new country. Corn will mature about 3 or 4 years out of 5. Corn for silage can always be counted on. The type is well adapted to general farming and dairying and it is along these lines that development is being made.

Because of the fact that agricultural development on this soil is comparatively new no very definite system of crop rotations has been worked out. The virgin soil is strong and productive and the question of maintaining its fertility has not received serious consideration. The greatest problem is getting the land

cleared and ready for the plow. The cost of removing the stones is sometimes equal to the cost of removing the stumps, though it is not necessary that either should be removed from any large proportion of a farm at first. Usually a tract sufficiently extensive for growing the desired cultivated crops is carefully cleared as rapidly as possible and the remainder brushed and gradually seeded. Excellent grazing is thus afforded and after a few years the hardwood and hemlock stumps will be sufficiently decayed to be taken out readily. As long as the land is used for grazing the stones which may be present are no serious handicap. Probably as much as 40 percent of the type is stone free, or the stones and boulders are present in the surface in such small numbers that they do not interfere with agricultural development nor detract from the agricultural value of the soil.*

Cut-over land of this type ranges in value from $12 to $25 per acre depending chiefly upon its location. Partly improved farms are valued at $35 to $50 or $60 per acre depending upon the amount of clearing, buildings, location, etc.

KENNAN SILT LOAM, ROLLING PHASE

Extent and distribution.—The rolling phase of Kennan silt loam is confined almost entirely to Taylor County, though a small amount is found in the extreme northwestern corner of Clark County. It occurs chiefly in the morainic belt which crosses Taylor County form the northeast to the southwest, and comprises a total area of approximately 95 square miles. The major portion of this type is in three separate areas—one in the extreme southwestern portion of Taylor County west of Lublin and south of Polly—one several miles to the northeast from Perkinstown, and the third in the extreme northeastern corner of the county.

Description.—The surface soil of this phase to an average depth of 8–10 inches consists of a brown or light brown, mellow silt loam which has a fair amount of organic matter in the virgin soil. The subsoil consists of a yellowish, or yellowish-brown silt loam grading into a heavy silt loam or silty clay loam, and at a depth of from 16 to 24 inches it passes into coarser textured ma-

*For a discussion of the chemical composition and improvement of this soil see page 40.

LEVEL COLBY SILT LOAM NEAR SPENCER

[illegible]

and dry. Dairying is the leading industry.

[illegible]

terial consisting of a fine sandy loam, sandy loam, or gravelly loam. Beds of sand or fine sand may also be encountered in the subsoil in places. The phase is quite similar to the typical soil, except that the covering of silty material is thinner and more irregular in the rolling phase. On many of the hill tops, and steep slopes the underlying gravelly and sandy material outcrops over small tracts, while along the lower slopes there is sometimes a deep accumulation of silt which reaches below the depth of the auger. Stones and bowlders occur upon the surface and mixed with the soil, but their occurrence is not uniform, and there are numerous tracts which are stone free. Stones are seldom present in sufficient numbers to retard or discourage agricultural development. The chief point of difference between this phase and the typical soil is a difference in topography.

Topography and drainage.—The surface of this phase varies from rolling to rough and broken, and a considerable proportion is steep enough so that modern farm machinery could be used only with difficulty or not at all. Pot holes, in which small areas of peat may be found, and lakes and ponds are quite numerous. On some of the ridge tops there is frequently a small amount of nearly level land, while in other places the ridge top is very narrow. Because of the uneven character of the surface and the loose open structure of the deep subsoil the natural surface, and the underdrainage are excellent, and somewhat excessive. When cleared many of the steeper slopes will be subject to erosion and it will be necessary to follow special methods to prevent destructive washing of the hillside land.

Origin.—The material forming this soil has been derived largely from the glacial debris deposited as a terminal moraine by the Late Wisconsin Ice Sheet. Practically all of the gravel and much of the fine material in the subsoil has come from the underlying crystalline rock formation, having been ground up and transported short distances by action of the ice. The silty covering may be in part of loessial origin, having been brought to its present position by the action of wind. There is no limestone in the region and an acid condition has developed in both soil and subsoil.

Native vegetation.—The original timber growth as on the typical soil consists of maple, birch, hemlock, with a mixture of white and some Norway pine. Much of the land has been cut

over but there is still considerable hardwood, and hemlock timber standing.

*Present agricultural development.**—The greatest amount of development on this phase is confined to the tract west of Lublin. By far the greater proportion is unimproved. It is adapted to the same crops as the typical soil, though its cultivation is somewhat more difficult because of its rougher surface. Where cultivated the crops grown and yields are about the same, and the same methods should be used for its higher development. This class of land is well suited to the development of the sheep raising industry.

Marathon Silt Loam

Extent and distribution.—The Marathon silt loam is confined entirely to Marathon County and is one of the important soils of the region surveyed, both from its extent and from the development which has taken place upon it. It covers a total area of approximately 290 square miles and occurs in an almost continuous body, near the center of which the city of Wausau is located. East of the Wisconsin river this type extends nearly to Hogarty and is confined largely to the north of the Eau Claire river. On the west side of the Wisconsin river the type extends to a point about 6 miles west of Marathon City and south to the Little Eau Plaine river. The continuity of the type is broken by tracts of Colby silt loam, and by a few areas of Marathon gravelly silt loam, and by a few sandy soils along the streams traversing the region.†

Description.—The surface soil of this type to an average depth of 10 or 12 inches consists of a yellowish-brown, friable silt loam in the surface few inches of which there is sufficient organic matter to impart a somewhat darker color to the soil. The subsoil consists of a yellow silt loam. With increased depth the texture gradually changes to a silty clay loam which extends to an average depth of 30 or 36 inches, beneath which yellow sandy clay, clay loam or fine sandy loam may be encountered. This type of soil very seldom has the heavy compact layer in the sub-

*For a discussion of the chemical composition and improvement of this soil see page 40.

† The area of Marathon silt loam along Pine river due east from Merrill should have been included with Kennan silt loam.

soil which is characteristic of the Colby soils, the angular gravel and small amount of other rather coarse material is scattered through the subsoil making it somewhat more open and permitting a more rapid movement of water through the soil section.

In texture and general surface characteristics this type is uniform over large areas, but there is some variation in the depth of the extremely silty covering forming the surface soil. In the vicinity of Halder and for several miles in all directions the soil is not as deep as elsewhere, and in addition is underlain by a bed of angular gravel known as arkose.

Much of the type north of Marathon City, north of Wausau, and between Sunset and Glandon contains disintegrated particles of the bed rock scattered through the lower subsoil. Along ridge tops, and on some of the steep slopes the bed rock often outcrops and is frequently encountered at a depth of from 2 to 3 feet.

Along the western border of this soil type is a long strip of land varying from one to four miles in width and which is about 22 miles long. This has been included with the Marathon silt loam but differs from the typical soil in being just outside of the unglaciated area. A few rounded bowlders on the surface indicate that there has been some glacial action over it, but this was undoubtedly very slight and not sufficient to materially change the character of the soil. This strip may be considered as an intermediate soil between the Colby and Marathon silt loams, but it resembles the Marathon in its important characteristics much more than it does the Colby and is therefore mapped as Marathon silt loam.

Glacial bowlders are found to a very limited extent, though most of the type is practically free from them. In some places angular rock fragments are found upon the surface and mixed with the soil.

This type is very similar in texture and agriculture value to the Kennan silt loam. It differs somewhat from this type by having a slightly heavier subsoil. It also differs from the Kennan in the origin of the subsoil, but agriculturally this is not important.

Topography and drainage.—The surface of this type over the greater portion of its extent is rolling, with some areas which

are gently rolling. The hills and ridges are usually broad, with long slopes. While there are some slopes too steep to be readily cultivated, modern farm machinery can be readily used on nearly all of this soil. Because of the uneven topography, and the coarse material in the deep-subsoil the natural surface and underdrainage are excellent. Where the beds of angular gravel occur the drainage is frequently excessive.

Origin.—The surface of this type is frequently loess-like in appearance, and may have been deposited in part by wind action. The subsoil is largely residual, having been formed by the disintegration of the underlying rocks, which are chiefly coarse grained granite. While a few glacial bowlders are sometimes found, the glacial action over this region was so slight as to have no appreciable influence on the formation of the soil.

No limestone has entered into the formation of this soil and both the soil and subsoil show varying degrees of acidity.

Native vegetation.—The original timber growth on this soil consisted chiefly of hardwood with maple as the predominant growth. Birch was quite plentiful in places and hemlock formed an important part of the growth. Some pine was found and in places it made up a large proportion of the tree growth. Most of the best timber has been cut, but there are still some rather extensive tracts of hardwood and hemlock, and numerous woodlots on the improved farms.

Present agricultural development.—The Marathon silt loam is an excellent general farming soil, and includes the best extensive tracts of land tributary to the city of Wausau. It is important not only because of the development which has taken place upon it up to the present time, but also because of its total extent. Its future development is a very important economic factor in the continued growth of Wausau. This class of land is well adapted to all of the general farm crops adapted to the climatic conditions prevailing in this region. Hay, small grains, root crops, potatoes, and corn for all do well. The region is especially well suited to grasses, and although acid, clover makes a rank growth on new land.*

* For chemical composition and improvement of this soil see page 40.

Marathon Gravelly Silt Loam

Extent and distribution.—This type of soil is not extensive, but is distinct from all other types which have thus far been mapped. It covers a total area of approximately 9 square miles and most of it occurs from 3 to 9 miles south and southeast from Marathon City in Marathon County. A few other scattered areas occur throughout the region which is covered with Marathon silt loam with which this type is always associated.

Description.—The surface soil of the Marathon gravelly silt loam to an average depth of 10 inches consists of a brown or dark brown silt loam which has an accumulation of a fair amount of organic matter in the surface 2 or 3 inches. Where fields have been cultivated this organic matter has been more thoroughly mixed with the surface section. The subsoil consists of a yellowish brown or light brown gravelly silt loam in which the gravel consists of angular fragments of granitic rock. At from 18 to 30 inches a gravel bed is usually encountered which consists of a mass of angular rock fragments varying in size from smaller than a pea to the size of about a hickory nut. The underlying granitic rock is usually encountered at a depth of from 3 to 6 feet, although on some of the hill tops and sharp ridges the underlying rook outcrops or comes to within 1 to 2 feet of the surface.

This type is quite variable in that the covering of silt over the angular gravel may range from a depth of only a few inches to 2 or 2½ feet. In a number of places the angular gravel is turned up by the plow so that the gravel forms a conspicuous feature in cultivated fields. As a whole, the silt covering is sufficiently shallow so as to make the type quite different in this respect from the Marathon silt loam.

Topography and drainage. The surface of this type is rolling and frequently consists of a series of rather sharp ridges. The natural drainage is always sufficient and often excessive, the subsoil being quite loose and open because of the high content of angular gravel.

Origin.—The material forming this type appears to have been derived from two sources. The extremely silty material forming the surface soil has a loess-like appearance and may have been deposited in part by wind action. The gravelly portion

of the type has undoubtedly been derived from the disintegrating of the underlying rock which is a coarse grained granite. It is probable that where the beds of gravel have outcropped on the higher elevations some of this material has been washed down and deposited over the silt on the lower slopes and in this way has become mixed with the soil section in various sections. It is also probable that in some cases the gravel has worked up into the silty covering. There is no indication of limestone rock in this region and both the soil and subsoil are found to show varying degrees of acidity.

Native vegtation. This is a hardwood soil and the original timber growth consisted chiefly of maple with some birch and a considerable amount of hemlock. There was also a small amount of pine scattered through the original forests.

Present agricultural development.—A small proportion of this type has been placed under cultivation and in most cases satisfactory crops are being raised. Where the silt covering over the gravel is shallow the type is inclined to be somewhat droughty. Portions of the type which are the most rolling are not well suited to cultivated crops, but can be used to advantage for grazing purposes. All of the general farm crops adapted to this region can be raised successfully on this type where the topography will permit.*

Vesper Silt Loam

Extent and distribution.—The Vesper silt loam is an unimportant and inextensive type, confined entirely to Clark County and accupying a total area of approximately 15 square miles. This soil is found in two distinct localities—one in the extreme southeastern corner of Clark County and the other about 5 miles to the southwest from Greenwood.

Description.—The surface soil of this type to an average depth of about 10 inches consists of a grayish-brown or dark brown silt loam in which the amount of organic matter is somewhat variable. The subsoil consists of a gray, drab, or sometimes yellowish heavy silt loam which may be mottled with brown, red, green or bluish coloring, and which at a depth of about 20 inches grades quite abruptly into sandy material. This may con-

* See page 40 for chemical composition and improvement of this soil.

sist of sand, fine sand, or medium or fine sandy loam. In some instances the underlying sandstone rock is encountered within the 3 foot section. In a few instances the underlying sandy material was found to be exposed at the surface.

The subsoil of the area near Greenwood is usually not quite as heavy as the subsoil of the other tract. While the type as a whole is quite variable, none of the variations were of sufficient extent or importance to be indicated separately.

Topography and drainage.—The surface of this soil is level to very gently undulating, and because of its low position, and the heavy character of the soil, the drainage is poor. The soil on account of this is cold and backward in the spring.

Origin.—The material forming this soil is from two distinct sources. The underlying sandy material has been derived from the weathering of the underlying Potsdam sandstone, while the silty covering may be in part residual from shale associated with the sandstone, or it may possibly owe its origin partly to glacial action. The region in which this soil occurs was influenced only to a very limited extent by glacial action, as it occurs along the border of the driftless area. The ice sheet which advanced to about this point was of Pre-Wisconsin age. The absence of limestone has permitted to development of a strongly acid condition in both soil and subsoil.

Native vegetation.—The original timber growth contained some ash, elm, and other moisture loving trees, and on the portions best dained some maple and birch. At present where not cleared the growth is largely small birch brush, poplar, and alder.

*Present agricultural development.**—A small proportion of the type has been cleared and placed under cultivation, but because of the poor natural drainage conditions the yields secured are usually not satisfactory. The tract southwest from Greenwood appears to have a somewhat higher agricultural value than that in the southeastern part of Clark County, although no larger proportion of it is under cultivation. In its present condition the soil is probably better adapted to the growing of timothy and alsike clover and to grazing than to any other line of farming.

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* See page 40 for chemical composition and improvement of this soil.

Antigo Silt Loam

Extent and distribution.—The Antigo silt loam is confined almost entirely to the eastern portions of Lincoln and Marathon Counties. It is not an extensive type, but it is one of the best soils in the area surveyed.

Description.—The surface of this type to an average depth of about 12 inches consists of a yellowish brown silt loam which is very smooth and friable. In the surface 2 or 3 inches there is a considerable amount of organic matter which has imparted a somewhat darker color than is found in the remainder of the soil section. Below 12 inches the soil is a yellow or drab silt loam which is frequently mottled. At a depth of about 2 feet a fine sandy loam or sandy loam is usually encountered. This is often of a yellowish color, though it is frequently mottled with red, brown, and drab. In a few places this lower depth was found to be a sandy clay loam. At a depth of 30 to 36 inches stratified beds of fine and medium sand are usually found.

This type is subject to numerous variations, especially in the depth of the silty covering over the underlying sand. This depth has an extreme variation of from about 10 inches to 4 or 5 feet, though these extremes are rarely found, the average depth of the silt being about 24 inches. The deepest silt covering was found in rather large areas in Towns 31, 32, and 33 North, Ranges 7 and 8 East. Over most of these tracts the silt extended to a depth of about 30 inches. In Towns 26, 27, and 28 North, Range 10 East, the underlying sandy material usually came to within 20 or 24 inches of the surface.

Topography.—The surface of this soil is level and where the silty covering extends to a depth of 2 feet or more the natural drainage is somewhat deficient. This is especially true where the type is adjacent to streams and on a rather low terrace. Where it is well elevated the underlying sand and gravel affords excellent drainage. When improved it will probably be found desirable to tile drain certain portions of this soil.

Origin.—The Antigo silt loam is of alluvial origin and has been derived largely from crystalline rocks. The silty covering over the sand was deposited in waters which were flowing at a much lower rate of speed than the waters which deposited the sand and gravel. It is possible that some of the fine material

may have been blown into quiet waters by the wind and then settled, thus giving a surface soil which has a somewhat loess-like appearance.

Native vegetation.—This is a hardwood soil and the original timber growth consisted chiefly of maple and birch, with a considerable amount of hemlock and smaller amounts of white and Norway pine. All of the pine has been removed, but there is still a considerable amount of hardwood and hemlock standing.

*Present agricultural development.**—This type of soil is recognized as one of the best in the area, though it is of comparatively small extent. Its freedom from stones and bowlders makes it much more desirable than some of the rolling country and the sandy subsoil makes it comparatively easy to remove stumps. It is a soil which may be worked readily and no difficulty is found in draining the land. It is well adapted to the general farm crops grown in this section and it is a soil which is certain to reach a very high state of development. The crops grown at present consist of clover and timothy, small grains, corn, and potatoes, all of which give very fair yields.

Knox Silt Loam

Extent and distribution.—The Knox silt loam occupies a total area of only about 6 square miles and is confined entirely to an almost unbroken tract in the extreme southwestern corner of Clark county in the immediate vicinity of Humbird.

Description.—The surface of this type to an average depth of about 8 inches consists of a light to dark brown smooth, friable silt loam. This is underlain by a yellow, buff, or yellowish-brown silt loam which gradually changes to a silty clay loam. At about 28 or 30 inches there is usually an abrupt change into a reddish, gritty, sandy clay loam. At a depth of 3 feet the underlying sandstone, or sand from this rock is frequently encountered, although the heavy material usually extends to a depth of over 36 inches. While this soil is associated with, and frequently grades into, boone fine sandy loam, as a type it is very uniform. The surface of this soil is stone free.

Topography and drainage.—The surface of this type is quite rolling, and because of this, and the underlying sandstone for-

* See page 40 for chemical composition and improvement of this soil.

mation the natural surface and underdrainage is always good. There are some rather steep slopes upon which erosion is apt to take place if the surface is not protected.

Origin.—The surface soil of this type is undoubtedly of loessial origin while the deep subsoil has doubtless come in part from the disintegration of the underlying sandstone. The sand particles have become mixed with the loessial material giving the gritty feel to the deep subsoil.

Native vegetation.—The original timber growth consisted chiefly of hardwood. Most of this has been cut, but on the steeper slopes there is still some timber.

Present agricultural development.—The greater proportion of this type is in farms and improved. It is a good general farming soil and well adapted to all of the usual crops grown in this region. Small grains, corn, hay, and root crops give satisfactory yields.

Chemical Composition and Fertility of Heavy Soils

The heavy soils of the Colby, Kennan, Marathon, Antigo, Vesper and Knox series have a good supply of the mineral elements, phosporous and potassium.

The total amount of phosphorous in an acre to a depth of 8 inches varies from 1100 to 1400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorous has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorous content of this layer of soil is retained at from 1500 to 2000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

The element potassium exists in very much larger amounts in these soils than does the element phosphorous—in fact they contain on the average over 40,000 pounds of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to potassium, therefore, is connected with its availability. When a good supply of active organic

matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorus which goes to the grain and is, therefore, more likely to be sold.

Compared with prairie soils which have shown a lasting fertility, these soils are distinctively low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. However, the vegetable matter which they do contain when first cleared and broken is of an active character, but provision should be made for maintaining and increasing this material. When stock raising is practiced manure is available and is of course good as far as it goes, but on comparatively few farms is there sufficient manure produced to maintain the organic matter in soils of this character and other means should be used to supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in organic or vegetable matter of the soil, there being none whatever in the earthy material derived from the rocks. Soils which are low in organic matter are, therefore, also low in nitrogen. By all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soybeans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element. When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or

alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm, but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies and to correct this condition will require from 2 to 4 tons of ground limestone per acre. In some cases it would require even more than this to completely correct the acidity. A slight degree of acidity does not interfere to any marked extent with the growth of clover while the soil is comparatively new and the fertility high, but does reduce the yield as the fertility is reduced by further cropping. Even in the virgin condition on this soil acidity does interfere with the growth of alfalfa. Acidity is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil, and thus all crops are directly or indirectly influenced to some degree by acidity. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop. They should also watch the growth of clover carefully from year to year, so as to begin the use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

These soils are well adapted to a wide range of crops, including corn, root crops, grasses and small grain. The Colby silt loam requires more care as to its drainage and cultivation than do the other soils, but its supply of essential plant food elements is as high as that of any of the others. All of these heavy soils are well adapted to the developmentof the dairy industry on account of their unusual fitness for the growing of hay and pasture.

CHAPTER III

GROUP OF MEDIUM HEAVY SOILS

Auburn Loam

Extent and Distribution.—The Auburn loam is confined largely to Clark county. Several small tracts are also found in Lincoln and Taylor counties. While not extensive as compared with the Colby soils, it nevertheless contains some of the finest agricultural land in the present survey. It occurs chiefly in a north and south belt along and mostly to the west of the Black river, beginning at a point four miles south of Neillsville and extending north for twenty miles to within several miles of Greenwood, where it swings to the northwest, crossing the county line about five miles south of the Soo Railroad. This belt is nearly continuous and varies in width from two to six miles.

Description.—The surface soil of the Auburn loam to an average depth of 10 to 12 inches consists of a mellow, brown or light brown loam or silt loam, in which there is usually a large percentage of fine and very fine sand. The subsoil consists of a lighter colored yellowish loam or silt loam, extending to a depth of from 24 to 30 inches where there is usually an abrupt change into material much lighter in texture and which consists of fine sandy loam, sandy loam, sand, or gravelly material. Frequently a mass of rather finely broken sandstone will be encountered in the subsoil, and in a few instances this was found to outcrop on the slopes. Glacial gravel is frequently present in the subsoil, and gravel beds are not uncommon. The surface soil while usually a loam, sometimes contains sufficient fine and very fine sand to justify calling the type a fine sandy loam, but such variations could not be separated out in a general survey.

Topography and Drainage.—The surface of this type ranges from gently rolling to steeply rolling, with the major portion which could be classed as rolling. Because of the irregular sur-

face, and the open nature of the subsoil the natural surface drainage is excellent and the under-drainage is good. There are very few slopes which are considered too steep to be utilized, and even the steepest land is of value for grazing. On by far the greater portion of the type modern farm machinery is being used. A little damage from erosion frequently results when the slopes are left without a crop covering them, but because of the open nature of the subsoil the amount of run-off water is reduced to the minimum.

Origin.—The material forming this soil appears to have been derived from several sources. The type is pactically all underlain by the Potsdam sandstone, from which the sandy material in the subsoil is largely derived. Dr. Samuel Weidman, who has studied the geology of this region very carefully, indicates that the belt of country of which most of this type forms a part, is a terminal moraine of one of the early ice sheets. The frequent deposits of glacial gravel indicate that at least a portion of the material has been influenced to some extent by glacial action. It is also possible that some of the material, especially that which is extremely silty has been brought to its present position by the action of the wind. There is no limestone present in this region, and an acid condition has developed in the soil.

Native vegetation.—The original timber growth consisted of maple, birch, hemlock, with a considerable stand of white and some Norway pine especially along the Black River. All of the pine has been removed, and also all of the best hardwood and hemlock.

Present agricultural development.—*A very large proportion of this soil is cleared and under cultivation, and it is considered to be one of the best types in the region. Because of its higher content of fine and very fine sand, it is easier to cultivate than the Colby soils, and because of its mellow soil and loose open subsoil the drainage is also much better. Most of this class of land is highly improved, and devoted to general farming and dairying. Corn, small grains, clover, and timothy and root crops are the chief crops grown, and very satisfactory yields are obtained.

* See page 54 for chemical composition and improvement of this soil.

VIEW OF IMPROVED FARM ON [illegible] ROAD IN CLARK COUNTY.

Kennan Fine Sandy Loam

Rolling Phase

Extent and distribution.—The Kennan fine sandy loam is one of the most extensive soil types in the region surveyed. It is found in all four of the counties. In Clark County it is quite limited in extent and is confined to the extreme northwestern corner. In Taylor County it forms an extensive belt from 3 to 10 miles in width extending from the southwestern corner in a northeast direction to the extreme northeastern corner of the county. In Lincoln County it occupies large areas in the central and northeastern portions, while in Marathon County it is confined to the southeastern corner of the county. Throughout its extent it is associated with Kennan silt loam, and in Lincoln County especially it is quite closely associated with Vilas fine sand as well as Kennan silt loam. Throughout the areas indicated it occurs in rather extensive tracts with smaller outlying areas mixed in with other types.

Description.—The surface soil of the Kennan fine sandy loam to an average depth of about 10 inches consists of a light brown or yellowish brown rather compact fine sandy loam with which there is a fair amount of organic matter incorporated. The surface soil of cultivated fields when thoroughly dry is rather of a grayish color, but becomes somewhat darker as the content of moisture increases. The subsoil consists of a fine sandy loam to sandy loam which becomes somewhat coarser in texture and somewhat lighter in color with increased depth. In a number of cases the deep subsoil below 24 inches was found to consist of sand or sand and gravel. There is present upon the surface and mixed with the soil varying amounts of gravel, the amount of which usually increases with depth. In some places the deep subsoil was so gravelly that it was found difficult to bore. The type in places is stony, the stones ranging in size from a few inches to several feet in diameter.

There are a number of variations in this soil and one which is quite common is in the color of the subsoil. In many places this consists of a reddish brown sandy loam or fine sandy loam instead of yellowish material. The texture of the subsoil is also somewhat variable and there are places where loam or silt loam is found making up the bulk of the underlying ma-

terial at a depth of 20 to 30 inches. In a few places the surface soil was also found to consist of a silt loam. The type as a whole may be considered as intermediate between the Kennan silt loam on the one hand and the Vilas sand and fine sand on the other, so that gradations between these limits are frequently found. Associated with this type are also a number of small marshy tracts occupying kettle-like depressions. All of these variations, however, were of such small extent that they could not be indicated on a general soil map. In a detailed soil survey it is probable that most of these variations could be indicated.

This soil has a rather loose friable structure and because of this it is easily cultivated and so far as the soil itself is concerned, it works readily into a mellow seed bed.

Topography and drainage.—The topography of the Kennan fine sandy loam is quite variable, but for the most part it is from rolling to broken and hilly. Most of this consists of a series of knolls and ridges, with intervening kettle holes and narrow valleys in which small marshy tracts and lakes are numerous. It is distinctly a morainic country and is confined almost entirely to the terminal moraine which marks the farthest point of advance of the Late Wisconsin Ice Sheet. Associated with this morainic belt are numerous small areas where the surface is undulating or only gently rolling. But because of the small and irregular extent of such areas no topographic separation was made in this type. In Sections 19 and 20 in Township 31 North, Range 1 West small patches of this character are found which were large enough to separate. Most of this type as found in Taylor and Lincoln Counties is quite broken. The portion which is found in the southeastern part of Marathon County has a less broken topography and may be described as from gently rolling to rolling.

Because of the surface features and the loose open character of the subsoil both the natural surface and under drainage are excellent, and sometimes excessive.

Origin.—The type owes its origin to the weathering of glacial till which was deposited over the crystalline rocks and it consists of material which was derived largely from this geological formation from the grinding action of the ice and the subsequent weathering. The greater proportion of the type occurs within

the terminal morainic belt of the Late Wisconsin Ice Sheet. Some of it is probably resessional moraine, and a portion of it may be considered as ground moraine. It may be that a small proportion of the sandy material incorporated with this type has had its origin in part from sandstone formations to the north, having been carried to its present position by ice action. There is no limestone material in this region and its absence has permitted the development of an acid condition both in the soil and subsoil.

Native vegetation.—The forest growth over this type consisted mainly of hemlock, maple, and birch with which there was a considerable mixture of white and Norway pine. Hemlock was the predominant tree growth and immense quantities of tan bark have been taken from this type of soil. On some of the lower portions of the type some elm was found and on some of the ridges basswood and oak also occurred. By far the greater proportion of the timber has been removed, though in some places there is still considerable hemlock and maple standing. Much of the type has been burned over by forest fires, leaving it in a very desolate looking condition. Where fires have not recently destroyed the second growth there is often a rather heavy growth of popple and birch.

Present agricultural development.—While quite a number of farms have been started on this soil, by far the greater proportion of the Kennan fine sandy loam is undeveloped. In Taylor County there is some settlement east of Lublin in Township 30, Range 3 West; also in the vicinity of Perkinstown and along the Soo Railroad between Whittlesey and the north line of Taylor County. In the south eastern portion of Marathon County there are also a number of small settlements. Some settlement has been made in Lincoln County on this type, but no large areas have been cleared. In some instances farms have been in operation on this type for 20 years, but the amount of clearing which has been done is limited. The soil in itself is of good quality and produces excellent yields. Heavy crops of clover, timothy, oats, barley, and rye are grown and excellent yields of potatoes and corn are secured. Corn is more certain to mature than on the heavier soils such as the Colby silt loam. Because of the extremely rough character of this soil, however, it has not been developed to a great extent and this roughness will have a ten-

dency to retard development in the future, because there are many portions which are so steep that modern farm machinery cannot well be used. In the improvement of this soil the type of farming followed should be modified somewhat from that which is followed on other soils of the region. In many places there are small areas of gently rolling land surrounded by the rougher portions of the type. If these less rolling areas are selected for cultivated fields and the remainder of the farm used largely for grazing purposes, this type may be profitably improved. This type is well adapted to grasses and will supply a large amount of excellent grazing so that the dairy industry could be well developed, and the soil is probably better adapted to the raising of sheep than any other type in the area, and this industry is one which could well be considered for extensive development on this class of land.*

The selling price of land of this character is somewhat variable, but will average from about 10 to 15 dollars per acre, depending on location, topography, stoniness, etc.

Antigo Fine Sandy Loam

Extent and distribution.—Antigo fine sandy loam is fairly well distributed throughout Lincoln County and the eastern half of Marathon County. The largest tract of about eight square miles is found in the southeastern corner of Marathon County.

Description.—The surface soil of the Antigo fine sandy loam to an average depth of about 10 inches consists of a brown fine sandy loam. In the surface 2 or 3 inches there is an accumulation of organic matter in the virgin soil which makes it somewhat darker than the remainder of the soil section. The surface soil is usually underlain by a yellow sand or fine sand extending to a depth of from 18 to 24 inches. Below this depth the soil is somewhat lighter in color and it varies in texture from a fine to medium sand. Throughout the soil section a small amount of gravel may be found and in a few localities a gravel bed was encountered at a depth of about 3 feet. The type is practically stone free.

* See page 54 for chemical composition and improvement of this soil.

This type is subject to some variation and small patches of fine sand, medium sand, and sandy loam may be found, but none of these are of sufficient extent to indicate separately. In a few localities the subsoil was found to be somewhat heavier than usual and to contain an appreciable amount of silt and clay. In some low places the surface soil was found to be quite dark in color and sometimes to approach a silt loam in texture.

Topography and drainage. The surface of this type is level and the drainage is fair to good, but there are a few places where the ground water is sufficiently close to the surface so that in the improving of this soil drainage will be needed.

Origin.—This type of soil is of alluvial origin and occurs as stream terraces or outwash plains. The parent material has been derived from crystalline rocks and carried to its present position through the action of water. There is no limestone in this region and all of this type is now found to be in an acid condition.

Native vegetation.—The original timber growth consisted of mixed pine and hardwood. In some localities the hardwood predominated, while in other sections the pine was the most extensive tree growth. Considerable hemlock was also found in places. All of the pine has been removed, but some of this type is still covered by hardwood and hemlock timber.

Present agricultural development.—A portion of this type has been placed under cultivation and where farmed very fair yields have been obtained. It may be considered very well adapted to the general farm crops which are grown in the region, and especially well adapted to trucking crops, though because of its location the trucking industry has not been developed. It is well adapted to potatoes and in order to secure the best returns a rotation consisting of one year small grain, one year clover, and one year potatoes should be followed.*

COLBY LOAM

Extent and distribution.—This type of soil is confined extirely to Marathon County and occupies a total area of about 23 square miles. The most important tracts are found in the vicinity of Ringle and about 8 miles east of Mosinee.

*For chemical composition and improvement of this soil see page 54.

Description.—This type is extremely variable, ranging in texture from a silt loam to a fine sandy loam, but because of numerous changes in texture within short distances, and because the major portion appears to approach more nearly to a loam than to any other type it was all included under the head of Colby loam, though a detail survey would doubtless be able to separate several types.

In general it may be said that the surface of this type to an average depth of about 12 inches consists of a brown or dark brown loam, which frequently becomes yellowish or reddish-brown within a few inches of the surface. The subsoil usually consists of a reddish-yellow sandy clay loam which frequently becomes heavier with depth, and is mottled with drab, brown and yellow. In a few instances the subsoil was found to contain considerable mica and some chlorite. At a depth of 4 feet the decomposed mica and chlorite schist was found. South of Ringle the subsoil contained considerable angular granitic gravel and where this was the case there was no mottling of the subsoil, doubtless because of better drainage. None of the variations found were of sufficient extent to be indicated on a general soil map of this kind.

Topography and drainage.—The surface of this type is flat to very gently undulating and the natural surface drainage as well as the under drainage, is deficient. Where the type approaches a silt loam the drainage is always poorer than where the texture is somewhat lighter.

Origin.—The subsoil of the Colby loam has doubtless all been derived from the disintegration of the underlying crystalline rocks, which are usually granite. Much of the surface soil has also had the same origin. Field tests indicate that both soil and subsoil of this type show varying degrees of acidity.

Native vegetation.—The original timber growth consisted of hardwood, mostly maple, and hemlock. The greater part of the merchantable timber has been removed and the land left in "slashing."

Present agricultural development.—But very little of this type has been placed under cultivation. Before farming operation can be carried on successfully from year to year it will be necessary to provide more thorough drainage than prevails at present. When the land is cleared the drainage is greatly im-

proved, but in the higher development of land of this character the use of tile drains will be found profitable, and often necessary.

When thoroughly drained this will make a good, productive soil. While the land is new clover will make a rank growth, but after crops have been grown for a time the use of lime will be beneficial. For alfalfa growing liming will be necessary. By removing the brush this type will afford excellent grazing without any additional labor.*

Marathon Fine Sandy Loam

Extent and distribution.—The Marathon fine sandy loam occupies a total area of about 3 townships. It is confined entirely to Marathon County, and is found east of the Wisconsin river between the Eau Claire river and the south county line. It is practically all found within 12 miles of the Wisconsin river. Only a few scattered tracts are found outside of the region indicated.

Description.—The surface soil of this type to an average depth of about 12 inches consists of a brown or rather dark brown fine sandy loam in the first few inches of which there is sufficient organic matter to give it a somewhat darker color than the remainder of the surface section. The subsoil consists of a yellowish-brown fine sandy loam which usually becomes lighter in color and texture until a yellow fine sand is often encountered at depths ranging from 14 inches to 3 feet. The lower portion of the 3 foot section is frequently a fine sandy loam, and in a few places a sandy clay loam was found in the lower subsoil.

Local variations in texture were noted both in the soil and subsoil, and ranges from fine sand to loam were observed, but none of these variations were of sufficient extent to be indicated on a general soil map.

Topography and drainage.—The topography over the major portion of the type is gently rolling to rolling, with some nearly level tracts and the natural drainage is usually good. An exception to this was found about 7 miles east of Schofield, where the surface is nearly level, rather low lying, and the drainage

*For chemical composition and improvement of this soil see page 54.

quite deficient. The subsoil of this phase shows mottlings of red, yellow and drab, and is quite compact. The subsoil is here frequently heavier than typical, due to larger amounts of clay, and in places possibly to a ferruginous cementing material. On this poorly drained phase bowlders are quite plentiful.

Origin.—This type of soil has been derived largely from the disintegration of the underlying crystalline rocks, and the variations in texture appear to be due largely to the variations in the texture of the rock from which derived. While this is considered to be a residual soil, the region has doubtless been traversed by glacial ice, but the influence of the ice sheet appears to be very slight. The rounded bowlders were transported by the ice, and it is possible that some of the soil material itself may also have been carried short distances by the ice. There is no limestone present in this region, and both soil and subsoil are found to show varying degrees of acidity.

Native vegetation.—The original timber growth consisted largely of hemlock and maple, with which there was varying amounts of pine. There is still considerable hardwood and hemlock standing.

Present agrciultural development.—Only a small proportion of this type has been cleared and placed under cultivation. Most of the development which has taken place occurs southeast of Schofield, and east of Mosinee. Along the main road due east of Mosinee for 8 or 9 miles a large number of 20 and 40 acre tracts are being developed into farms largely by foreigners who have been located on the land by a larger lumber and land company operating in this locality. This type of soil is well adapted to general farming and all crops adapted to this region give satisfactory yields. Small grains, hay, potatoes, and roots are the chief crops now grown.*

AUBURN FINE SANDY LOAM

Extent and distribution.—The Auburn fine sandy loam is confined to the western and southern portions of Clark County, the most extensive area occupying from 5 to 16 miles west and northwest of Greenwood. In this tract there is over 50 square miles.

* See page 54 for chemical composition and improvement of this soil.

The type is quite closely associated with Boone fine sand and also with the Auburn loam, and it may be considered as an intermediate type between these two.

Description.—The surface soil of Auburn fine sandy loam to an average depth of 8 or 10 inches consists of a light brown fine sandy loam which is usually underlain by a yellow or yellowish brown fine sandy loam. In places the subsoil has a somewhat reddish appearance, this condition usually being found close to the sandstone mounds where the soil is rather shallow and where the underlying rock has a reddish cast.

The type is subject to considerable variation and in a number of places the surface may approach a loam in texture, while the subsoil frequently consists of a heavy fine sandy loam or sandy clay loam. This heavy phase is found chiefly in the northern extension of the type northwest of Greenwood.

There are a few areas of limited extent which approach the Boone fine sand type in texture. The subsoil in a number of places is found to grade into a fine sand at a depth of from 2 to 3 feet, while in a few places the bed rock may be encountered at about the same depth.

Topography and drainage.—The surface of Auburn fine sandy loam is usually gently rolling to rolling, so that the natural drainage is good; in some places it is excessive. Associated with the type are a number of large mounds or hills where the underlying rocks outcrop to such an extent as to justify calling such places rough stony land.

Origin.—This type of soil has been derived chiefly through the weathering of the underlying sandstone formation. The region in which this soil is found appears to have been influenced to a very slight degree by glacial action, but this has not been sufficient to materially change the character of the soil material. A very few small glacial bowlders are found scattered over the type and a very small amount of gravel mostly consisting of crystalline rocks was also seen. No limestone formations occur in this region and practically all of the type is found to be in an acid condition.

Native vegetation.—The major portion of the type as it occurs northwest of Greenwood supported a good growth of hardwood and hemlock timber with which there was mixed a small amount of pine. The southern areas which are somewhat lighter

in texture supported a larger proportion of pine timber. By far the greater proportion of the timber growth has been removed.

Present agricultural development.—Only a comparatively small proportion of the type has been cleared and put under cultivation, but where improved it is proving to be a very fair soil. All of the general farm crops which are grown in this region give satisfactory yields, especially over that portion of the type lying to the northwest of Greenwood which is somewhat heavier than the remainder of the type. The chief crops grown consist of small grains, corn, and hay.

Chemical Composition and Fertility of Loams and Fine Sandy Loams

These soils are only a little more open in texture than the silt loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than are the heavier soils.

The total amount of the plant food elements, phosphorous and potassium, is nearly if not quite as large in the Kennan and Marathon fine sandy loams as the Kennan silt loam. However, they have rather less organic matter and this together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh orgainc matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of actvie organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of

clover or a crop of soybeans, is the best method of securing this result. The application of phosphorous and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

These soils were derived from rocks devoid of lime carbonates and therefore have a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition on this soil acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorous in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

These soils are well adapted to general farming and some special crops such as potatoes can also be grown to good advantage.

CHAPTER IV

GROUP OF MEDIUM SANDY SOILS

Vilas Sandy Loam

Extent and distribution.—The Vilas sandy loam is of very limited extent and is confined to the northeastern part of Lincoln County and to the eastern and northern portions of Marathon County. The most extensive tract, of several square miles, occurs in the vicinity of Granite Heights.

Description.—The surface soil of this type to an average depth of about 10 inches consists of a brown or grayish brown sandy loam of medium texture with which there is incorporated a small amount of organic matter. The subsoil consists of a yellowish brown or rather rusty colored sandy loam which contains a rather high percentage of fine sand. With increased depth the soil becomes more of a sandy nature and the deep subsoil usually consists of a yellow or slightly yellowish red sand. There is a small amount of gravel scattered through the soil section and a small amount may appear upon the surface in places. The type is quite similar to the Vilas gravelly sand type, but contains somewhat more fine material and a smaller amount of gravel. The type is subject to some variation, but none of the variations were of sufficient extent to separate on the general soil map.

Topography and drainage. The surface of this soil is rolling to hilly. Kettle basins, kames, and small marshy tracts are quite common. There are a few level and undulating tracts included with the rougher country but these could not be indicated separately. Because of the surface features and the open nature of the sub soil the natural drainage is sufficient and usually excessive.

Origin.—In origin the material composing this soil has been derived from glacial material which has been deposited chiefly in the form of recessional moraines. The greater proportion of the material has doubtlessly been derived from the underlying

crytalline rocks, though it is possible that sandstone formations far to the north have contributed to its formation also. There is no limestone found in this region and an acid condition has developed in both the soil and subsoil.

Native vegetation. The original timber growth consisted chiefly of pine with which there was mixed a considerable amount of hemlock and also a small amount of hardwood consisting chiefly of maple with some birch. All of the pine has been cut, but there is still some hemlock and hardwood standing.

Present agricultural development.—Only a very small amount of this type has been placed under cultivation. Because of its rather rough character and somewhat droughty condition its agricultural value is rather low and while it can be farmed successfully, the production of profitable crops upon it will require careful management. So long as there are extensive areas of much better land which can be secured at a reasonable price, it would not be advisable to urge the improvement of this class of land at the present time.*

Marathon Sandy Loam

Extent and distribution.—This type of soil is of comparatively small extent. The largest tract is found within a triangle formed by Moon, Dancy and Mosinee. Smaller areas occur between Marathon City and Wausau, to the northwest of Ringle, and about 5 miles southeast from Rothschild. None of this soil is found outside of Marathon County.

Description.—The surface soil to an average depth of 10 inches consists of a brown or grayish-brown sandy loam of medium texture. Below 10 inches the material becomes a yellowish, or sometimes a reddish-brown sandy loam or sand, carrying a high percentage of angular gravel. At a depth of 2 to 3 feet this usually grades into a bed of angular gravel consisting entirely of disintegrated crystalline rock. Sometimes the underlying crystalline rock (usually granite) comes to within 3 feet of the surface.

The type is quite variable and includes small areas of loam, silt loam and fine sandy loam, all of which were of too limited

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* See page 64 for chemical composition and improvement of this soil.

extent to be shown on a general soil map. In a few instances small spots of sand and fine sand were included with the type.

Topography and drainage.—The surface of this type is usually rolling, and on account of this and the underlying gravelly material the natural surface and under drainage is excellent, and sometimes somewhat excessive.

Origin.—This soil has had its origin from the disintegration of the underlying crystalline rocks, which are usually granite, or granite gneiss. The gravel present consists of small angular fragments of this rock which are being slowly transformed into soil. Gravel beds making up of this material are known as arkose. No limestone material has entered into the formation of this soil and both soil and subsoil show varying degrees of acidity.

While this soil is considered to be of residual origin it is known that this region was traversed by glacial ice, but its action was slight. The few rounded bowlders seen here and there were brought to their present position by the ice, but beyond this the glacier seems to have had but little influence.

Native vegetation.—The original timber growth consisted chiefly of hardwood and hemlock, and the greater proportion of this has been cut. Some pine was mixed through the hardwood, but this has all been removed.

Present agricultural development.—But very little of this soil is under cultivation at the present time. In its agricultural value it is very similar to the Marathon fine sandy loam, differing from that type chiefly by being underlain by angular garvel. Where cultivated fair yields of most of the general farm crops common to the region are secured.*

Vilas Fine Sand

Extent and distribution.—This type occupies a total area of about 30 square miles and is confined to the northern part of Lincoln County along both sides of the Tomahawk River north of Tomahawk, and between the Tomahawk and Wisconsin Rivers.

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* See page 64 for chemical composition and improvement of this soil.

Description.—The surface soil of this type to a depth of about 6 inches consists of a brown or grayish-brown fine sand which grades into a reddish or rusty brown fine sand and then at from 12 to 18 inches into a yellow fine sand which extends to a depth far below the reach of the auger. There is present in soil and subsoil sufficient clay to give the material a slightly loamy feel. A small amount of gravel is frequently found scattered through the soil section. The type is subject to some variation and includes small patches of fine sandy loam, sandy loam and gravelly sand, some of which could be mapped separately in a detail survey. Stones and bowlders frequently occur.

Topography and drainage.—The surface of Vilas fine sand is for the most part rolling, broken and hilly, consisting largely of moraines in which kettle basins, kames and sharp ridges are quite common, small marshes abound. An exception to this topography is found to the northeast and northwest from Tomahawk, where the surface is nearly level, approaching the Merrimac fine sand, but has numerous bowlders upon the surface in places. Because of the surface features and structure of the material this type has excellent drainage, and is often droughty.

Origin.—The material forming this soil has been derived largely from the underlying crystalline rocks by glacial action. It seems probable that in addition some material from sandstone formations to the north may have been carried down and mixed with the crystalline rock debris by glacial action. There is no limestone present in this region and soil and subsoil are acid.

Native vegetation.—The original timber growth was largely pine, though there were areas over which some hemlock and frequently some hardwood grew. Birch and popple brush and sweetfern largely make up the present growth.

Present agricultural development.—A small percentage of this soil is under cultivation, and it has a producing power somewhat higher than the Vilas gravelly sand and sand types, but it is lower in value than the fine sandy loam. Where not too rough and broken it can be farmed profitably but it requires careful management. The crops grown consist chiefly of small grains, potatoes, hay and a small amount of corn. Fair yields are usually secured. Difficulty may be experienced in getting clover started, as the soil is acid. Where clover cannot be grown without lining the soil, such legumes are soy beans or serradella may

be successfully grown. A rotation consisting of a small grain, followed by clover, followed by potatoes usually gives good results on this class of land.*

PLAINFIELD SANDY LOAM

Extent and distribution.—The Plainfield sandy loam is a type of minor importance and is confined almost entirely to Marathon County. The principal tracts occur along the Little Eau Claire River about 4 miles west of Bevent and another tract is found about 2 miles northeast of Hogarty. Other small patches occur along Trap River east of Trap City and along the Wisconsin River south of Merrill.

Description.—The surface soil of the Plainfield sandy loam to an average depth of about 8 or 10 inches consists of a brown medium sandy loam in the surface few inches of which there is a small amount of organic matter. The subsoil usually consists of a reddish brown or rusty sandy loam which at a depth of about 2 feet grades into a gravelly sand of a rather reddish color. At a depth of about 3 feet it is quite common to find the material of a more yellowish cast. The lower portion of the subsoil is usually stratified and lenses of gravel and coarse and fine sand are quite common. In a few places a small amount of sandy clay or clay loam was found at a depth of about 30 inches, but this condition was unusual.

The type as a whole is subject to some variation. The tract which occurs near Bevent is somewhat heavier than usual and contains patches which approach a loam in texture. In other places the texture was found to approach that of a fine sand or fine sandy loam, but none of these variations were of sufficient importance to indicate on the soil map.

Topography and drainage.—The surface soil of this type is level and occurs as river terraces. Its position is somewhat lower as a rule than that of the Plainfield sand and gravelly sand and because of this fact the natural drainage is sometimes deficient. The ground water level frequently comes within 3 feet of the surface, and where this is the case the type is rather wet especially in the spring and early summer. Where the type oc-

* See page 64 for chemical composition and improvement of this soil.

cupies a second terrace the drainage is very fair and sometimes excessive.

Origin.—This type has the same origin as the other types of the Plainfield series, having been deposited by stream action when the waters were at a much higher level than at present. The material forming this soil has been derived largely from the underlying crystalline rocks which consist largely of granite.

Native vegetation.—The predominant growth on this soil consisted of white and Norway pine, all of which has been removed.

Present agricultural development.—Only a small proportion of this type has been placed under cultivation. It has an agricultural value somewhat above that of the Painfield sand and gravelly sand, but it is not as good a soil as the Antigo fine sandy loam. Most of the general farm crops of the region are being grown upon it to a limited extent, but the yields are rather low and the type as a whole under present conditions must be classed as a soil of rather low agricultural value.*

Plainfield Fine Sand

Extent and distribution.—The Plainfield fine sand is not an extensive type, but it is found in three of the four counties included in the present survey. One of the largest areas is found in the northern part of Lincoln County extending to the northeast from Tomahawk along the Wisconsin River. In Marathon County there is an area of considerable size extending for about 7 miles to the southwest of Bevent along Plover River. At Knowlton in the southern part of Marathon County there is another tract of several square miles along the Wisconsin River. In Clark County there are several small patches along the Black River in the southern part of the county and also scattered areas along the Wolf River in the northwestern portion of Clark County.

Description.—The surface soil of the Plainfield fine sand to an average depth of about 8 inches consists of a brown or yellowish fine sand in the surface inch or two of which there is sufficient organic matter to give the material a dark brown color. The surface soil is underlain by a brown, reddish brown, or

* See page 64 for chemical composition and improvement of this soil.

rusty fine sand which usually grades into a yellow fine sand at about 18 or 20 inches below the surface. This yellow fine sand may extend to a depth of 3 feet or more, though a number of places were found where the brownish or rusty color extended to the depth of the auger. Throughout the soil section there is a very small amount of silt or clay which is sufficient to make the soil stick together when wet. In a few places a small amount of gravel was found scattered through the soil and in the deep subsoil.

Gravel beds, however, were not found. In a few instances a very compact layer of reddish fine sand was found at a depth of about 8 inches which seemed to be cemeted together by a ferriferous material. This condition, however, seemed to be of very limited extent. In such places the surface was usually a whitish or gray fine sand and the drainage was much more defective than usual.

Topography and drainage.—The surface of this type of soil is level to very gently sloping. Because of the loose character of the soil and subsoil the natural drainage is thorough and usually excessive except in such localities where the type is low and the ground water rather near the surface which is sometimes the case.

Origin.—The Plainfield fine sand occurs chiefly as a terrace formation, though in some cases it probably consists of outwash material. The terraces are always sufficiently above the level of the streams along which they occur to be free from flooding and some of the terraces have an elevation of 20 to 30 feet above the present flood plain. The upland material from which this soil has been derived is the crystalline rock formation which prevails throughout this region. There is no limestone material in this region and both the soil and subsoil of this type are found to be in an acid condition.

Native vegetation.—The original timber growth consisted largely of white and Norway pine, all of which has been removed. The present growth consists of a few small pine trees with a ground covering chiefly of sweet fern, some birch, and a small amount of popple.

Present agricultural development.—But very little of this type has been cleared and placed under cultivation. Its agricul-

tural value is slightly higher than that of the Painfield sand, but it will require careful management to produce profitable crops.*

BOONE FINE SAND

Extent and distribution.—This type of soil occupies a total area of about 40 square miles and is practically all found west of Black River and in the southwestern fourth of Clark County. There are only a few scattered areas outside of the above region in the southern part of Clark County. The largest occurrence of this type consists of about 30 square miles and lies immediately south of Mentor and Tioga and to the east and northeast of Humbird.

Description.—The surface soil of the Boone fine sand to an average depth of about 8 inches consists of a fine brownish or yellowish sand which contains only a small amount of organic matter. The subsoil consists of a yellow fine sand which extends to an average depth of 3 feet or more. In a few places the subsoil was found to consist of a nearly white fine sand. The underlying sandstone rock may be encountered anywhere below a depth of 2 feet, and there are a few places where the underlying rock outcrops. Around Mentor and to the south of Tioga some gravel was found scattered about the surface and mixed with the soil. This gravel is largely of crystalline rock material. The soil in this region appears to have a somewhat higher agricultural value than where no gravel is present. The occurrence of the gravel, however, was not sufficiently uniform or extensive to warrant a separation on this basis.

Topography and drainage.—The surface of this soil is usually undulating to gently rolling and in a few instances rolling. Because of the uneven surface and the loose open character of both the soil and subsoil the natural drainage is excessive and the type is subject to drought for a large portion of each growing season. Along the south fork of the Eau Claire River and also along Hay Creek there is a narrow strip of this type which has a nearly level surface and over this portion of the type the water table comes much closer to the surface than usual so that a droughty condition would seldom prevail over this phase.

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* See page 64 for chemical composition and improvement of this soil.

Origin.—This type has been derived from the weathering of the underlying Potsdam sandstone and is considered to be a residual soil. As in the case of the fine sandy loam, this type may have been influenced to a very slight extent by glacial action, as is indicated by the presence of glacial gravel; this influence, however, has been so slight as to have no appreciable effect. The type has, therefore, been included with the Boone series. There is no limestone present in this region and both the soil and subsoil are found to be in an acid condition.

Native vegetation.—The original timber growth on this type consisted chiefly of white and Norway pine, all of which has been removed. The growth at present consists chiefly of scrub oak, a small amount of second growth pine, and an undergrowth of sweet fern.

Present agricultural development. Only a small proportion of this type has been put under cultivation. Where fields have been cleared the chief crops grown consist of corn, rye, potatoes, and clover, but the yields of all of these crops are rather low and the type as a whole may be considered as having a low agricultural value.

Chemical Composition and Fertility of Medium Sandy Soils

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn, and potatoes, find sufficient moisture during the average seasons and suffer from drought only during periods of relatively low rainfall.

This moderate water-holding capacity permits these soils to dry off more quickly in the spring and to become warmer than heavier soils, thus fitting them especially for such crops as corn, potatoes, and other crops requiring a warm quick soil. The water holding capacity can be considerably improved by increasing the organic matter.

In chemical composition these soils are also of an intermediate character. The total phosphorous averages from 850 to 900 pounds in the surface 8 inches per acre. The total potassium of the surface 8 inches per acre is approximately 25,000 pounds

or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2 per cent in the second 8 inches. They have a correspondingly low nitrogen content averaging from 1000 to 1500 pounds in the surface 8 inches and form 500 to 800 pounds in the second 8 inches. This organic matter is largely in the form of leaf-mold and fine roots and is hence of an active character so that it decomposes quickly when the surface is first broken, furnishing a sufficient supply of nitrogen for a good growth of crops for a few years. But it is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa, liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover, but assists in preventing the leaching of phosphorous and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other live stock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phoshhorous, pottassium, and nitrogen. But even when stock is maintained, it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of the stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover occasionally all of which is to be plowed under as a green manuring crop will be found profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorous and potassium will be found necessary to maintain the soil at a point of productivity for a considerable number of years. Clover or some other legume

must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorous and potassium in order to secure a good growth of this clover, and there is little loss in so doing since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorous and potassium is desirable in the management of these soils it must not be considered that this is an indication that they have less value than heavier soils which are relatively higher in these elements for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts, and the finer tilth which these fine sands and sandy loams develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204 and 230 of the Wisconsin Experiment Station.

CHAPTER V

GROUP OF SAND SOILS

VILAS SAND

This soil occupies a total area of only about 2 square miles and is confined to the northeastern part of Lincoln County where it joins larger tracts of similar soil in Oneida County to the north.

The surface consists of a brown or grayish brown medium to fine sand to a depth of 3 to 4 inches where it passes into reddish-yellow or rusty sand which becomes a yellow sand below 2 feet. This loose, open sand extends to a great depth. The soil is similar to the gravelly sand of this series, but differs from that by being practically free from gravel.

The surface is undulating to gently rolling, and the natural drainage is excessive.

The soil has been derived by glacial action from the underlying crystalline rocks and from sandstone formations far to the north. The absence of limestone has permitted the development of an acid condition in both soil and subsoil.

The original timber growth consisted chiefly of pine, though there was some hemlock and a very small amount of hardwood. All the best timber has been cut.

This soil is all cut over but still unimproved. It has a rather low agricultural value and to produce profitable crops will require careful management. So long as there are large tracts of better land available, it is doubtful if, under present conditions, the improvement of this land should be encouraged.*

VILAS GRAVELLY SANDY LOAM

The Vilas gravelly sandy loam covers a total area of approximately 30 square miles and is confined to a nearly continuous body in the northeastern part of Lincoln County in the vicinity

* Chemical composition and improvement discussed on page 72.

of Long, Bass, and Pine Lakes. It may be considered as one of the unimportant types.

The surface material to a depth of about 3 inches consists of a gray or light brown gravelly sand or fine sand which then passes into a reddish, brownish-red, or rusty colored sand or fine sand having a loose open structure, grading at about 18 inches into a yellow or yellowish-red sand of about the same texture, which extends to a depth far below the reach of the soil auger. Gravel varying in size from that of a pea to that of an apple, is found all through the soil section. Bowlders frequently occur upon the surface.

The type is somewhat variable, frequently containing small patches of sandy loam or fine sandy loam, especially along some of the lower slopes. The surface of this soil is decidedly broken in topography and geologically would be classed as a recessional moraine. Hummocks, kettle basins, kames, eskers, and sloughs are numerous. Many small lakes dot the landscape, and small tamarack and cedar swamps are plentiful. Because of the uneven surface and the open character of the material the drainage is excessive and the soil is droughty.

The material composing this soil has been derived from the glacial debris deposited by the Late Wisconsin Ice Sheet. This came largely from the underlying crystalline rocks, though it is probable that sandstone formations may have contributed to its origin also. An acid condition has developed.

The present growth is largely hemlock with some birch. Originally there was also considerable pine.

This soil has not been improved and because of its rough surface, loose open structure, and droughty condition it has a low agricultural value. To produce profitable crops will require careful management, and the improvement of this class of land is not encouraged under present conditions, when there is so much land of much better quality readily available.*

Plainfield Sand

Extent and distribution. The principal areas of Plainfield sand are found in Marathon County in the valley of the Wisconsin River in the vicinities of Dancy, Mosinee, Granite

* Chemical composition and improvement discussed on page 72.

[illegible] ...nage excessive, and its natural fertility is low. With proper cultivation, lime and fertilizers [illegible]

Heights, Wausau, Merrill, and to the north of Tomahawk. Other areas occur west of Dancy along the Big and Little Eau Plaine Rivers, between Wausau and Marathon, along Big Rib River, and also along Plover River near Bevent. One tract is found immediately east of Humbird and another occurs along both sides of the Black River in the southern part of Clark county.

Description. The surface soil of Plainfield sand to an average depth of about 10 inches consists of a brown medium sand in the surface 2 or 3 inches of which there is sufficient organic matter to make the color somewhat darker than the remainder of the soil section. This is undelain by a reddish brown sand which is loose and open in structure and which may contain considerable gravel. This material extends to a depth of over 3 feet. The lower section is usually stratified and consists of layers of fine and medium sand and gravel.

The type is subject to considerable variation, though most of the variations are of too small extent to be indicated on a general soil map. In the vicinity of Bevent the subsoil is usually a loose yellow sand, in place of a reddish brown sand, and there is a much higher content of fine sand in this locality than elsewhere. The underlying beds of gravel which occur in various places are sometimes found within 12 inches of the surface and occasionally gravelly spots will be found at the surface, so that in such places the type could be properly termed a gravelly sand.

Topography and drainage.—This soil occurs as terraces along the various streams and the surface is flat or very gently sloping. Along the Wisconsin River and some of the other streams there are often two and sometimes three distinct terraces. The difference in elevation between these terraces ranges from a few feet to over 20 feet. While the texture of the soil on the various terraces is uniform, the drainage conditions vary somewhat—the higher lying soil having better drainage than the lowest terraces. Over the type as a whole the drainage is very thorough and frequently excessive and there are only a few places where the water level is sufficiently close to the surface to make the drainage deficient. The lowest portions of the type have been indicated by marsh symbols.

Origin.—The Plainfield sand is of alluvial origin, having been deposited by the Wisconsin River and its tributaries when these streams were flowing at a much higher level than at present. These streams all traverse a region of crystalline rocks and it is this class of material which has contributed largely to the formation of this type of soil. There is no limestone in this region and practically the whole of this type is now found to be in an acid condition.

Native vegetation.—The original timber growth consisted almost entirely of pine. In most places white and Norway pine was the predominant growth, while in others Jack pine was quite plentiful. All of the pine timber of any value has been removed.

Present agricultural development.—Only a small proportion of the Plainfield sand is under cultivation. Because of the small amount of organic matter present and also the limited amounts of the mineral plant food elements found in this type it must be considered as a soil of rather low agricultural value. Where it is under cultivation at the present time the crops grown consist chiefly of rye, potatoes, some oats, and a small amount of corn and some hay. Because of the acid condition of the soil it is difficult to get clover started. Profitable crops can be grown only when the very best of methods are followed.*

Plainfield Gravelly Sand

Extent and distribution.—The Plainfield gravelly sand is confined almost entirely to Marathon County and occupies a total area of about one township. By far the greater proportion of this soil occurs along the Eau Claire River east of Schofield and along the Wisconsin River between Schofield and Mosinee. A few other much smaller tracts occur on terraces along some of the other streams traversing Marathon County.

Description.—The surface soil of this type to an average depth of about 8 inches consists of a brown or dark brown gravelly sand which is quite loose and open in texture. In the surface inch or two of the virgin soil there is usually a fair amount of organic matter which gives it a somewhat darker color. This

* For chemical composition and improvement see page 72.

largely disappears after cultivation for a few years. The subsoil consists of a reddish brown gravelly sand which is very loose and open in structure, but which usually contains sufficient silt and clay so that when moist the material will stick together slightly. The gravel present ranges in size from a pea to about the size of a hen's egg. The lower portion of the soil section is usally stratified and a bed of gravel is sometimes found at a depth of about 3 feet.

Included with this type are numerous small areas of Plainfield sand which differs from the gravelly sand only in that it does not contain gravel. It was found in a number of cases and where these two types bordered each other the line between them was an arbitrary one. There are also a few places where the texture of the soil is somewhat finer than usual, but none of these variations were of sufficient extent to indicate on this general map.

Topography and drainage.—The surface of this soil is level and because of the loose open structure of the material the natural drainage is excessive. This is true in all cases except where the type occupies a position lower than usual and where the ground water comes within 3 feet of the surface which is rarely the case.

Origin.—The Plainfield gravelly sand occurs chiefly as river terraces, though it may also occur as outwash plains. There are several different terraces and in a number of places three distinct levels are noticeable. These range in elevation from 4 or 5 to about 20 feet or more above the pesent flood plains of the streams along which they occur. The material forming this soil has been derived from the crystalline rocks which form the underlying formation throughout this region. No limestone formations occur in this section of the state and both soil and subsoil are found to be in an acid condition.

Native vegetation.—The original timber growth consisted largely of white and Norway pine, though in some instances Jack pine was often growing on this soil. All the timber of any value has been removed. At the present time there is a small amount of popple, some birch, and a considerable amount of sweet fern growing on this type.

Present agricultural development.—Because of the loose open character of this material the soil is droughty and has a low

agricultural value. The amount of organic matter is small and the type is deficient in mineral plant food elements. Only a small proportion of the Plainfield gravelly sand has been placed under cultivation. Unless special lines of treatment are followed the yields secured are low.

Chemical Composition and Fertility of Vilas, and Plainfield Sands

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing periods. But when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of the growing crops and they therefore suffer from drought. Moreover, most sandy soils are lower in their supply of the chemical elements demanded by crops than heavier soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as fine sands or sandy loams have fairly good water-holding capacity and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of and they can be farmed with profit. But soils which are classified as sands, such as the Vilas, and Plainfield sands are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grian and that on small portions of soils mapped as sands a more detailed mapping would show fine sands. With very unimportant exceptions, the soils mapped as Vilas, and Plainfield sands in this area are of a very sandy character and profitable farming will be possible on them only when they are managed with unusual care and the crops to which they are best adapted are grown. The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or fineness of grain and cannot be affected by any treatment it is practicable to give them. The water-

holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparatively slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in these soils is moderate. The total phosphorous in the surface 8 inches per acre averages between 1000 and 1100 pounds and in the second 8 inches between 600 and 700 pounds. The total potassium in the surface 8 inches per acre is approximately 25,000 pounds in comparison with 50,000 or 55,000 pounds in the silt loam soils of that region. The total nitrogen content is between 1200 and 1400 pounds in the surface 8 inches per acre. When a sufficient supply of active organic matter is developed in these soils a considerable portion of the phosphorous and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed.

The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. The growth of a good crop of mammoth clover or soybeans through the use of mineral fertilizers containing phosphorus and potassium is the best means of supplying this nitrogen and organic matter. The use of a complete commercial fertilizer will often be found pofitable. This crop should be plowed under as a green manuring crop.

A rotation which experiments have demonstrated to be well adapted to sand soils consists of rye, clover and corn. Best results in securing a stand of clover are usually secured by seeding with rye which may be disked and harrowed in and seeded to clover in the spring. Where the fertility of the land is low, the entire clover crop should be plowed under. Where the fertility of the sand is fair, the first cutting of clover may be saved for hay, and the second plowed under as a green manuring crop. As these sands are acid best results with clover cannot be secured without the use of lime. By using corn in the rotation instead of potatoes there will be a considerable increase in the acreage of corn, which will make possible the use of silage for summer

feeding. This in turn will reduce the number of acres devoted to pasturing and this is especially desirable on sand soil because of the fact that the sand does not produce good pasture. The supply of stable manure on these soils is always limited, and the use of commercial fertilizers may frequently be found advisable for general farm crops.

While considerable acreage of this soil is devoted each year to growing potatoes for home use and on a commercial scale, careful field tests have demonstrated that increased yields of corn can be secured much more readily on this soil than can increased yields of potatoes. In other words, potatoes do not respond well to the improvement of this soil, while corn responds readily to improved methods of cultivation and fertilization on sand. It will be desirable therefore to reduce the acreage of potatoes on sand soil as much as possible and to increase the acreage of corn. The potatoes are better adapted to sandy loams, and fine sands, and fine sandy loams, all of which have more fine material than the extremely sandy soils.*

*Extensive experiments have been carried on on Plainfield sand near Sparta, information on which may be secured by writing to the Soils Department, of the Wisconsin Experiment Station.

CHAPTER VI

GROUP OF POORLY DRAINED AND MISCELLANEOUS SOILS

PEAT[1]

Extent and Distribution.—Areas of Peat are distributed throughout all four counties, but are most extensive in the glaciated regions in southeastern Marathon, nothern, central, and southwestern Lincoln, and northern Taylor County. In the region spoken of as unglaciated very extensive areas are found where no Peat marshes occur. The most extensive tracts of Peat are found southwest of Mosinee Hill and from 7 to 12 miles west of Dancy along the Little Eau Plaine River. In Clark County areas of Peat are found in the southern and western portions.

Description.—The material mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a raw fibrous condition, showing plainly the remains of vegetable growth from which derived. This raw fibrous material is of a brown color, but the more thoroughly decomposed it becomes the darker is the color. That which is well decayed is usually black or very dark brown. Small quantities of mineral matter may be incorporated with the organic matter, but when this becomes sufficient to change the texture appreciably, the material is classed as Muck. In the extensive areas of Peat little mineral matter is found, except about the margins, where there is frequently sufficient inorganic matter present to form Muck. Because of their limited extent, however, the areas of muck have been included with the Peat.

The depth of Peat is variable and ranges from 10 inches to over 20 feet. In practically all of the swamps where the area is a square mile or more in extent the Peat is over 3 feet deep. In

[1] See Bul. No. 205, Univ. of Wis. Exp. Sta., on the Development of Marsh Soils.

many of the smaller patches there is a margin of several rods where the underlying material can be reached at 12 to 20 inches, while in the center of the marsh it will be over 3 feet below the surface. In some of these places, however, the entire tract is shallow and where the depth of the Peat was less than 18 inches the material was mapped as Shallow Peat.

In the large swamps and marshes where the material is still raw there is very little difference between the character of the surface material and that several feet below the surface. Where conditions have favored rapid decomposition the material in the surface soil is frequently considerably darker than at lower depths. A profile section of such material may consist of from 8 to 16 inches of black, fairly well decomposed organic matter, underlain by a brown, or light-brown, raw, fibrous material extending to a depth of from 3 to 20 feet.

The material underlying the Peat is variable and ranges from sand to silt loam or clay loam. In general it may be stated that the texture of the underlying material is determined largely by the texture of the upland soil in the vicinity of the Peat areas. Throughout the areas of silt loam the underlying material is usually heavy and of a light-gray or bluish color. Throughout the sandy portions of the area practically always the Peat is underlain by a grayish or nearly white fine to medium sand, and in some instances there is considerable gravel mived with the sand.

Topography and drainage.—The surface of practically all of the Peat areas is level or has only a very gentle slope toward the water course along which it occurs. This slope is nowhere sufficient to drain the excess moisture from the Peat without the use of open ditches. Most of the Peat areas are wet for the greater part of the year and there is often a few inches of water over the surface in the spring, when most of the heavy rains occur. There are a large number of the Peat marshes which are on a sufficient slope to enable them to be successfully drained. In fact, it seems very probable that far the greater proportion of the Peat in the area is so situated as to permit of drainage. Up to the present time, however, only a very small proportion of it has been reclaimed. Along Little Eau Plaine River a drainage district has been established to reclaim a large tract of marsh land. Other drainage projects are now being developed

but the total area of Peat land actually producing crops is very small. On a few individual farms small patches of Peat have been reclaimed, but by far the greater proportion is unimproved.

Native vegetation.—The vegetation on the areas of Peat consists chiefly of tamarack, cedar, and spruce. There are a number of marshes which at present either do not support any timber or have only a scattering growth of spruce or tamarack. In most of these places the original timber has been completely destroyed by fire, though there are a few marshes which it seems were always treeless. On some of the open marshes there is now a growth of coarse grass which is cut for hay, though in the majority of cases the vegetation consists of sphagnum moss, cranberry vines, and other moisture-loving plants.

The underlying formation consists of sandstone or crystalline rocks and the upland soils are made up entirely of noncalcareous material. The Peat is practically all acid.

Peat

Shallow phase

The total area of Shallow Peat is very limited. It is most extensively found in southern and western Clark County, and in scattered areas in the eastern half of Marathon County, with a few small tracts in other portions of the survey.

The material composing Shallow Peat consists of decaying vegetable matter in varying stages of decomposition, with which there may be mixed varying amounts of mineral matter. In some instances there is sufficient mineral matter to make the material a true muck, but because of its small extent a separation on this basis could not well be made in a general survey. In some places the Peat is raw and fibrous, while in others it is fairly well decomposed. The chief point of difference between the Shallow Peat and the typical peat is that the Shallow Peat never extends to a depth of over 18 inches. The underlying material is variable. In regions where the upland soils the heavy the subsoil of the Shallow Peat is usually a silt loam or clay loam, quite strongly mottled. Where the uplands are sandy the material is usually light—a sand or sandy loam, or in some cases a fine sand. The depth of the peat is variable and may range from 6 or 8 inches to 18 inches. In Clark County this

phase includes a few low sandy islands which were too small to be indicated on the map.

The surface features are the same as typical Peat and the phase occupies similar positions, though usually of smaller extent. Because of the low flat position the natural drainage is very deficient.

The origin of the Peaty portion of this phase is the same as the deep Peat, but the subsoil is residual in the sandstone country in southern and western Clark County, and glacial or residual from crystalline rocks over the remainder of the area. All of the Peat is in an acid condition.

The native vegetation varied. There was some tamarack in places, alder in others, and frequently some ash and elm trees. Some of the marshes were open and supported a heavy growth of coarse marsh grasses.

The cutting of marsh hay is about the only use to which this soil is being put at the present time, aside from supplying some grazing. In its present condition it has a low agricultural value, and before it can be farmed successfully it will be necessary to thoroughly drain it.

Chemical Composition and Fertility of Peat

The chief difference between peat soils and upland soils consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorous, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorous in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds, or in two feet 1350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorous less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorous. They contain on the average 0.3 per cent of potassium, while good upland clay loam soils average two per cent or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account, it

will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent, and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorous and potassium. These elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat the manure should be used on the upland soils and commercial fertilizers containing phosphorous and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Frosts on Marsh Land.—It is well known that frosts frequently occur on marsh land when there is no frost on higher land. This is partly because the cold air which forms on the surface of all the ground at night tends to flow down and collect in low places, but it is also the result of the fact that the loose, spongy soil of peat marshes does not conduct the heat received from the sun during the day downward. In consequence of this, the lower layers of soil do not become warmed in peat marshes as they do in other earthy soils and the little heat left in the surface inch or two of soil is rapidly lost at night by radiation, so that the freezing point is frequently reached on such soil when it would not be on more earthy soils such as sandy

loam or clay loam which would conduct the heat downward better during the day and so keep warm farther into the night.

This difficulty with peat marshes can be overcome to a certain extent by heavy rolling which, by compacting the soil, permits the heat to be conducted downward more readily. It will also to a certain extent become less in time, as the peat decomposes and takes on more of the character of muck. Nevertheless, it must always be expected that marsh land will be more subject to late Spring frosts and early Fall frosts than high land. It may be stated as a general guide, that the occurrence of killing frosts is as liable on marsh land at any given point as it is on upland soil having good air drainage about 150 miles farther north; in other words, the marshes of Dane County are as liable to have a frost which will kill corn as early as are the upland regions of Shawano, Marathon, or Clark Counties. The marsh land regions of the area surveyed are liable to have frost two weeks or more earlier than the hill tops of the same latitude.

Crops and System of Farming on Marsh Lands.—Since the growth of corn and potatoes to which these marsh lands would otherwise be well adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops, and rye, and to a less extent oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land not too raw, good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

On account of the crops to which this land is adapted and its use as a pasture, marsh lands can be used for dairying or stock raising to good advantage.

Certain special crops, such as cabbage, onions, buckwheat, and rape, are well adapted to such lands when well drained and fertilized.*

*For more complete discussion of the management of marsh soils see bulletin on this subject by the Agricultural Experiment Station.

WHITMAN SILT LOAM

Extent and distribution.—The Whitman silt loam is not an extensive soil, but it is found rather widely distributed throughout practically all portions of the area surveyed. Tracts which have been mapped usually range in size from 40 acres to 2 or 3 square miles, though there are a few areas which are somewhat larger than this.

Description.—The surface soil of the Whitman silt loam to an average depth of about 10 or 12 inches consists of a dark gray to black silt loam which usually contains a large amount of organic matter. This high organic matter content accounts largely for the dark color of the soil. The subsoil consists of a heavy gray silt loam which with increased depth gradually becomes somewhat heavier until at about 20 inches the material is a silty clay loam or clay loam which is usually strongly mottled with red, yellow, and brown. The subsoil is quite compact and the heavy material usually extends to a depth of over 3 feet.

In texture and structure the soil section is variable, and in many places the color of the surface soil is considerbaly lighter than the average. In a few places the subsoil was found to consist of asandy clay at a depth below 2 feet. In a few instances beds of stratified sand were found in the lower subsoil. Such variations, however, were of too limited extent to be indicated in a general survey. In general it may be said that the lighter colored phase is confined to Clark and Taylor Counties and the western part of Marathon County, although in these same regions the dark phase may also occur. The portion having the lightest textured subsoil occurs in regions where the upland contains more or less sandy material.

In a few instances, especially in Marathon and Lincoln Counties, isolated sections were found upon which stones and bowlders were very plentiful; these areas, however, were very small and symbols were used to indicate their location.

Topography and drainage.—The surface of the Whitman silt loam is level or very gently sloping. It usually occurs as narrow strips along the flood plains of streams or as rather small depressed areas in the upland. It occupies a position similar to the Clyde soils. There are a number of tracts where the surface is flat and where the soil is very similar in position to the

Colby silt loam, except that it is a trifle lower, making the drainage somewhat more deficient. Because of the heavy character of the material and its low position the natural drainage of this entire type is very poor.

Origin.—The material composing the Whitman silt loam has probably been derived from several sources. A large amount of the surface material is probably of the same origin as the Colby and Marathon soils. In some places where the material occurs in the flood plains of streams it is undoubtedly of alluvial origin. It may be that in a few instances it is a lacustrine deposit. Possibly some of the material has been influenced to a greater or lesser extent by glacial action. Litmus tests in the field indicate that both the soil and subsoil are strongly acid.

Native vegetation. The timber growth on the Whitman silt loam is made up of a great variety of trees. Ash and elm are quite common in some places, especially where the drainage is the most deficient. Over the better drained portions some birch, maple, and hemlock were also seen. Over some portions of the type no large timber has developed, but there is a dense growth of willows or alder. In a few instances a heavy growth of marsh grass was noted.

Present agricultural development.—On account of its low position and very poor drainage, but very little of this type of land has been improved. In a few instances small fields have been cleared and placed under cultivation, but because of its wet condition in the spring it is very difficult to put in cultivated crops. Some marsh hay is cut from this land in a few places and this is the most important crop which the type produces at the present time.

Chemical composition and fertility.—This soil is well supplied with mineral plant food elements and also with nitrogen and organic matter. From the standpoint of plant food which it contains it is doubtless the best balanced soil in the area. When this land has been supplied with good drainage the soil will prove to be very productive and well adapted to general farming. Without drainage it is doubtful if it can be utilized except for cutting hay and use as pasture.

VESPER FINE SANDY LOAM

Extent and distribution.—The Vesper fine sandy loam is confined almost entirely to the southwestern and southern parts of Clark County. One belt extends about 6 miles north and south from Columbia and has a width of from 1 to 5 miles. Another belt extends from the Black River east along the south Clark County line to within 2 miles of the southeast corner of this county. This belt has a width of from 2 to 5 miles. There are a few other scattered areas located in the same general regions. About 8 miles east of Knowlton in Marathon County there are 2 or 3 small tracts of this soil which amount to something less than one square mile.

Description.—The surface soil to an average depth of about 10 inches consists of a gray or yellowish fine sandy loam in the surface few inches of which there is a small amount of organic matter. The texture of the surface soil is somewhat variable and over limited areas may range from a fine sand to that of a loam or even a sandy clay loam. The subsoil of this type is also quite variable, but usually consists of a yellow or whitish fine sandy loam grading into light colored clay loam or sandy clay loam. Beneath the surface soil it is quite common to find a layer of gray or nearly white sand which may extend to a depth of 18 or 20 inches where a whitish or bluish clay is encountered. This clay or clay loam may have a depth of from 1 inch to 10 or 12 inches or sometimes more, and is frequently very plastic and impervious. This may grade into another layer of fine sand or it may rest immediately upon broken fragments of shaly sandstone rock. Rock fragments are very often found through the soil section and in some places the underlying sandstone comes within 18 inches or 2 feet of the surface. Under practically all of the type the sandstone can be reached within 3 or 4 feet of the surface. In many places small fragments of the underlying shaly rock appear on the surface. The color of the heavy material underlying this soil is extremely variable and may be gray, yellow, or nearly red, and frequently it is strongly mottled.

Topography and drainage.—The surface of this phase varies from flat to very gently undulating and the natural drainage is deficient. An exception to this is found on a few gentle slopes and low elevations where drainage is sometimes sufficient. The

poor drainage is due to two causes. The position of the type is usually rather low so that the ground water would be quite near the surface. In addition to this the underlying rock and beds of heavy material are sufficiently close to the surface to hold up any water which may fall upon the surface. During the spring and early summer the soil is extremely wet. After it has had sufficient time to thoroughly dry it up it is subject to drought because the moisture from underneath cannot readily reach the surface owing to the impervious layer in the subsoil.

Origin.—In origin this soil has been derived from the weathering of the underlying formation which consists of Potsdam sandstone. This sandstone formation has associated with it a rather shaly formation and it is from this source, it is thought, that the heavier portions of the type have been derived, while the fine sand has doubtless come from the disintegration of the sandstone itself.

Native vegetation.—The original timber growth over the main portion of this phase consisted chiefly of white and some Norway pine. This, however, has all been removed and there is now a second growth of popple and smaller brush including birch, gall berry, etc. On the small areas in Marathon County the present growth consists chiefly of small scrub red oak.

Present agricultural development.—Only a very small proportion of this type has been cleared and placed under cultivation. In a few places where fields have been cleared the land has been cultivated for a few years and then allowed to remain idle because of the low yields secured.

Chemical composition and fertility.—The surface soil as indicated is usually deficient in organic matter and nitrogen, and it has also been found to be deficient in the mineral plant food elements, especially phosphorous. These factors combined with the deficient drainage give this type in its present condition a rather low agricultural value.

In the improvement of this soil the first step should be supplying thorough drainage. When this has been provided the organic matter should be increased and in order that clover or alfalfa can be grown the soil should be limed, for it is all in an acid condition. The use of some mineral fertilizers would be desirable and possibly necessary, especially where stable manure is not obtainable. Such crops as timothy and alsike clover can

be raised successfully without the use of lime. When thorough drainage has been provided and a larger amount of organic matter supplied to the soil along with mineral fertilizers fair crops of corn and small grains can be grown. The system of farming best adapted to this class of land is one which will make possible the use of a considerable portion of it for pasture. It should provide very good grazing when cleared and sufficiently drained.

Genessee Silt Loam

Extent and distribution.—The Genesee silt loam is a type of minor importance. In Marathon County a small area is found east of Dancy along the Wisconsin River, and other tracts occur along the Little Eau Plaine river. A number of small tracts are found in Clark and Taylor Counties, especially along the Black River and along the south fork of the Eau Claire river.

Description.—The material composing this type of soil is extremely variable in texture and might well be classed as meadow land. A soil section which is probably the most common consists of a light brown silt loam extending to a depth of about 12 inches. The subsoil consists of a yellow or yellowish brown silt loam which at a depth of 18 or 20 inches usually grades into a a yellowish fine sandy loam or fine sand and gravel. In some instances the depth of the silty material was much greater than this and it was frequently found to extend to a depth of 3 feet or more. In such cases the subsoil was usually mottled. In a number of other cases the sandy layer in the subsoil was found to come much closer to the surface and in a few instances the surface soil was found to consist of a fine sandy loam. In general it may be said that the heaviest phase of this type is confined to the region where the upland soils consist largely of silt loam, while the sandy phase occurs in regions where the upland soils are inclined to be of a sandy nature. Probably the most extensive tract of the sandy phase is found along the south fork of the Eau Claire river and its tributaries in the western part of Clark County.

Topograhpy and drainage.—This type occurs chiefly as narrow strips adjacent to streams and is almost always first bottom land subject to frequent overflow. Because of its low position the natural drainage is poor. In some instances where the bot-

tome land is a quarter of a mile wide it might be possible to drain some of this land. In most cases, however, where the bottoms are narrow it will be difficult to install drainage systems without lowering the bed of the stream along which it occurs. There are a few cases where the surface of this type is somewhat higher than usual and this condition is found adjacent to the upland. In such places the drainage is sometimes sufficient to permit the growing of cultivated crops. In Taylor County this type includes a number of areas which are commonly referred to as "beaver meadows" over which the poor drainage is largely due to the construction of dams by beavers.

Origin.—The material forming the Genesee silt loam is largely of alluvial origin and has been derived from the glacial, or residual material covering the region throughout which this type is found. The portion of the type adjacent to the highland may in some instances be partly colluvial. There is no limestone in this region and because of its absence an acid condition has developed to a marked degree in both the soil and subsoil of this type.

Native vegetation.—The original timber growth on this soil is varied, but consists largely of ash and elm. In a number of cases there is no growth of large trees but a dense growth of alder and willows. In some cases the only growth is coarse marsh grass.

Present agricultural development.—None of this type has been placed under cultivation chiefly because of its extremely poor drainage. In some instances marsh hay is being cut, but this is practically the only use which is being made of the type aside from its supplying a small amount of pasture.

Genesee Sand

Extent and distribution.—The Genesee sand is of limited extent. It is confined to Lincoln and Marathon Counties. The principal developments of this soil occur in the flood plains of the Wisconsin, Eau Claire, Big and Little Rib, and Little Eau Plaine Rivers in Marathon County. A number of small narrow bands of this type are found in the flood plains of many of the streams, but are often too small to be indicated on the soil map.

Description.—The surface soil of this type consists of a brown or light brown loose open sand extending to a depth of about 8 inches. The subsoil consists of a yellow or yellowish brown medium sand which is very loose and open in structure. This extends to a depth of 3 feet or more and in the deep subsoil it is common to find lenses of coarse sand and gravel.

The texture of this soil is quite variable and in a number of places small areas were found which could be classed as a sandy loam or a fine sandy loam had they been of sufficient extent.

Topography and drainage. The surface of this type is level or has a very gentle slope toward the stream along which it occurs. It is found as first bottom land and is subject to overflow. The natural drainage, therefore, for the greater part of the year is poor. When the streams are low, however, during dry seasons this soil dries out quickly.

Native vegetation.—On the better drained portions of the type some pine originally grew, while on the wettest portions willows and other water-loving trees and brush are frequently seen. Some portions of the type do not support any timber growth.

Present agricultural development.—But very little of this type has been placed under cultivation because of its low value and also because of the fact that most of it is subject to overflow. The type is deficient in organic matter and also in the mineral plant food elements. It is considered as having a low agricultural value and in order that crops may be successfully grown it will require very careful management. Because of the dangers of flooding in connection with its low fertility, it would not be advisable to attempt the improvement of this soil at the present time.

Dunning Sand

This is one of the inextensive and unimportant types of soil mapped in the present survey. It is confined chiefly to the southern and southwestern portions of Clark County where it is closely associated with the Vesper fine sandy loam. A few small patches occur in Marathon and Lincoln counties.

The surface soil of Dunning sand to an average depth of about 6 inches consists of a dark gray or nearly black medium to fine sand, containing considerable organic matter, especially in the first few inches. The subsoil is quite variable but usually

consists of an almost white medium or fine sand. Lenses of clay an inch or more in thickness are frequently found in the subsoil. The color of the surface is also variable, the most uniform characteristic of the type being its low set condition, and low present value.

The surface of this soil is generally flat, but in some instances it may extend some distance up a gentle slope where seepage keeps the ground wet. Both soil and subsoil are in a waterlogged condition much of the time and uniformily poor drainage is a characteristic of the type.

In origin the material forming this soil has been derived chiefly from the Potsdam sandstone. That found in Marathon and Lincoln Counties is partly from granite rocks. The dark color is due to the growth and partial decay of waterloving plants, but this accumulation has not been sufficient to make a Muck of Peat. In a few places where the type is adjacent to streams it may be partly alluvial.

The original timber growth was largely white pine but the present growth is largely scrubby alder, popple, mixed with gall berries, wintergreen, etc.

In its present condition this type has a low value, and but very little of it has been placed under cultivation. Drainage will improve this soil somewhat, but because of its low content of plant food it will require very careful management to produce profitable crops over a period of years. Money and labor can be expended to much better advantage on almost any of the other soils of the area.

Rough Stony Land

The material mapped as Rough stony land consists of a series of rock outcrops which take up such a large proportion of the surface that it is impossible to grow cultivated crops, and the land has no value for agricultural purposes beyond supplying a limited amount of grazing. While there is some soil between the outcrops, it is usually shallow, and in places sandy.

Rough stony land occurs in two portions of the area—one to the southwest from Wausau including Rib Hill and Mosinee Hill in Marathon County, and the other in western and southwestern Clark County, including North, Middle and South Mound, and several other tracts north of Humbird.

The Rock outcrop occurs as the highest portions of large hills, and on Rib Hill an elevation of 1940 feet is reached which is the highest point in the state. In all cases where Rock outcrop has been mapped it is the highest portion of the region and a conspicuous feature of the landscape.

The rock formation on Rib and Mosinee Hills consists of quartzite, while the bluffs in western Clark County are made up of Potsdam sandstone. Where sandstone prevails the intervening small areas of soil are sandy. Where the quartzite rocks are found the soil is usually a silt loam.

The only agricultural use being made of any of this land is for grazing, and only a very small amount is used for this purpose. It is very steep and broken, and rocky and in many places it would be difficult for stock to travel over it. It may be considered as non-agricultural land, and as having a lower value than any of the other portions of the area surveyed.

CHAPTER VII

AGRICULTURE AND CLIMATE

General Agriculture

The most reliable records available indicate that the first farming operations in the area surveyed were undertaken by a settler in what is now Berlin Town, Marathon County, in 1856. At that time the total population of Marathon County was about 500, but these early settlers were engaged in other industries than farming. The following year a number of families, some coming from Germany, settled in the region for the purpose of farming. Farming operations were begun about the same time in Clark County, but in neither of these counties was agriculture important prior to the close of the Civil War.

It was thought at first that the winters were too long and the summers too short for farming, but it was soon demonstrated that good crops could be grown in almost all parts of the area. Many of the early farmers were obliged to cut the timber and burn the logs, as the hardwood was of little value, only the pine being handled by the mills. It was a common practice in the early days, and is at the present time in the less developed sections, for farmers to work in the logging camps and mills during the winter months and to cultivate their fields and clear additional land in the summer. The farming methods originally followed were crude, but the virgin soil was very productive, and heavy yields were often obtained with little attention given to seed selection or cultivation.

Between 1870 and 1880 a large number of new farms were taken up in Marathon and Clark Counties; and, according to the census of 1880, there were 1,705 farms in Marathon County and 1,556 in Clark in that year. At this time comparatively few farms were operated in Taylor and Lincoln Counties. After 1880 agriculture developed rapidly, especially in Clark and

Marathon Counties, and at the pesent time large sections of these two counties are as thickly settled and as highly developed as many of the leading farming districts of southern Wisconsin. In Taylor and Lincoln Counties, however, there are large tracts of cut-over land in which no settlements have been made, and also extensive tracts of virgin forest of hardwood and hemlock.

The crops grown most extensively by the early settlers were hay, oats, and potatoes and other root crops. Oats and hay early became important sources of income, as the lumbermen required large quantities of feed for their stock. Wheat was grown to some extent in the older communities for a number of years, but the small grains have never attained as much importance here as in older sections of the State, chiefly because the oldest agricultural communities here had just become well established when grain growing elsewhere was at its height. With the decline in grain production more general farming was practiced, and dairying came to occupy an important place. Hay was often cut 5 to 10 years on the same field, and when the yields were no longer profitable the field was plowed for other crops. Little thought was given to crop rotation in the early days.

The following table, compiled from U. S. Census reports, shows the growth of the area surveyed in population and agricultural development since 1880.

Increase in Population and Agricultural Development

	Marathon	Clark	Taylor	Lincoln
Per cent of land area in farms:				
1890	27.76	23.82	10.34	11.00
1900	44.50	41.80	16.30	17.10
1910	53.60	52.80	21.50	21.60
Total number of farms:				
1880	1,705	1,566	266	153
1890	2,789	2,086	752	504
1900	4,276	3,456	1,168	924
1910	5,080	4,196	1,582	1,119
Total population:				
1880	17,121	10,715	2,311	2,011
1890	30,369	17,708	6,731	11,008
1900	43,256	25,848	11,262	16,269
1910	55,054	30,074	13,641	19,064
Value of all dairy produce exclusive of home use:				
1880	....	....	....	....
1890	....	....	....	....
1900	$136,058.00	$188,979.00	$26,598.00	$29,411.00
1910	883,816.00	1,171,341.00	240,383.00	138,753.00
Av. value of farm property per acre:				
1900	$14.29	$19.57	$10.88	$10.57
1910	29.35	34.68	23.31	21.67

The growth of the dairy industry, during the past 20 years, especially in Clark and Marathon Counties, has been marvelous. In Clark County alone the value of dairy products sold, as reported by the census, increased from $188,979.00 in 1900 to $1,171,340.00 in 1910. At present it is estimated that the yearly value of dairy products is close to $2,500,000. With this rapid growth in dairying has also come an increase in the acreage of

hay, corn, and small grain, and also a very substantial increase in land values

Chief Crops Grown.—The crops most extensively grown, in about the order of acreage devoted to each, are hay, oats, barley, corn, potatoes, rye, and wheat. There are more than twice as many acres in hay in the area as there are in any other one crop. The average yield of all kinds of hay is about 1½ tons per acre, but clover and timothy frequently yield from 2 to 3 tons per acre on the best soils. The Colby silt loam is the best hay and grass land in the area. On the Kennan and Marathon silt loams good yields of hay are also secured. The light sandy types are not well adapted to hay crops and yields are small. Some clover seed is grown, mostly medium red. The soils in this region show varying degrees of acidity so that alfalfa cannot be successfully grown without liming the soil. Inoculation is also necessary. The acreage given to alfalfa is very small.

Oats are grown more extensively than any other grain crop, in fact the acreage of oats is greater than the combined acreage devoted to all other grains. The average yield for the entire area in 1909 was approximately 30 bushels per acre. Yields on the light sandy soils are small, but on the silt loams and fine sandy loam types yields of 50 bushels per acre are common and 70 to 80 bushels per acre are frequently reported. Much of the oats is fed to stock on the farms, but on most farms the crop is also a direct source of income.

Barley is the second grain crop in importance and in 1909 there were 12,244 acres in Marathon County, and 9,063 acres in Clark, with 1,510 acres in Taylor, and 1,178 acres in Lincoln. The average yield that year was about 25 bushels per acre. Most of the crop is grown on silt loam types and some on fine sandy loam, on both of which it does very well. On the lighter soils yields are low. On the best fields yields of 35 to 50 bushels are not uncommon.

Corn is the third grain crop in the area from the standpoint of acreage. Yields of 40 to 50 bushels per acre are not uncommon and higher yields are sometimes reported. Large amounts are grown for silage in Clark and Marathon Counties; it is safe to say that the acreage put into the silo is larger than that which is allowed to mature. As dairying develops the number of silos also greatly increases and the acreage devoted to corn is ex-

tended. Golden Glow, Silver King, and Wisconsin No. 8 are dent varieties that are successfully grown in addition to the native yellow dent corn of mixed breeding. Flint corn is also grown. Loams and heavy fine sandy loams make the best corn land for this region, since these warm up earlier than heavier types. Level portions of Colby silt loam and Antigo silt loam are rather "cold" and "late."

Rye is grown in all four counties, but only to a rather limited extent. Yields average about 18 bushels per acre. It is grown mostly on the sandy soils and does better on such types than any of the other small grains.

Wheat has never been extensively grown in this region, but it can be raised successfully. In 1909 the yield from 1878 acres in Marathon County was about 15 bushels per acre. In Clark County there were 1116 acres devoted to the crop during the same year.

Potato growing has not been extensively developed on a commercial scale within the area except at a few points. The sandy types of soil within the valley of the Wisconsin River and its tributaries produce most of the potatoes. On the heavy soils such as the Colby silt loam potatoes are grown chiefly for home use. Average yields are largest where the bulk of the crop is grown on sandy soils. The varieties grown most extensively are Early Ohio, Triumph, Hebron, Early Rose, Rural New Yorker, and Burbank. Efforts are being made to encourage the growing of fewer varieties and purer strains in order to secure more uniformity in market and seed stock.

Peas are grown chiefly for seed, though not to a great extent. In 1909 there were 1,699 acres in Marathon County and less than 400 acres in any of the other three counties. The crop does well on many of the soils and could be profitably grown to a greater extent. Yields usually range from 15 to 20 bushels.

Buckwheat is frequently grown and with success, but the acreage is not large. Yields usually range from 15 to 18 bushels per acre.

While beans could be grown successfully in many portions of the area, the acreage devoted to this crop is small. They are grown chiefly on the sandy soils.

The following table, compiled from the Thirteenth Census,

gives the acreage production in 1909 of various general farm crops in each of the four counties surveyed.

Approximate Acreage and Production of Chief Crops by Counties

	Marathon	Clark	Taylor	Lincoln
Approximate land area in square miles ..	1,554	1,218	991	902
Number of farms	5,060	4,196	1,582	1,119
Hay and forage:				
Acres	69,596	60,239	18,239	13,678
Tons	102,477	104,261	27,951	17,909
Corn:				
Acres	3,742	8,833	214	275
Bushels	131,419	264,560	7,587	7,944
Oats:				
Acres	38,085	24,455	3,507	5,087
Bushels	1,058,750	809,770	112,960	168,328
Barley:				
Acres	12,244	9,063	1,510	1,178
Bushels	312,449	234,002	40,620	27,294
Potatoes:				
Acres	6,856	2,992	1,193	1,477
Bushels	649,764	336,540	170,356	199,890
Rye:				
Acres	3,985	2,972	523	297
Bushels	62,194	59,378	10,955	5,282
Peas (dry):				
Acres	1,699	376	196	257
Bushels	26,795	7,729	4,479	4,105
Wheat:				
Acres	1,878	1,116	70	107
Bushels	29,493	20,625	1,536	1,952

Special Crops.—There are a few special crops and truck crops grown within the area, though no one line of intensive agriculture has become highly developed in this part of Wisconsin. Sugar beets can be grown successfully, though the present

acreage is very small. Kennan silt loam and the well drained areas of the Colby silt loam and Antigo silt loam are well adapted to this crop.

Ginseng is grown by quite a number in various parts of the area, but the total acreage is small. One of the gardens at Wausau has the reputation of being the largest in the United States. All gardens are artificially shaded and great care and patience are necessary in growing this crop. The salable products from this plant are the dried roots, dry seed, and germinated seed, though the dry roots constitute the main product. The dry roots bring from 4 to 7 dollars per pound on the local markets. It requires 18 months for the seed to germinate and it is about 5 years from the time the seed is planted until the roots are large enough to be marketed.

Fruit and Truck Crops.—The trucking industry is not extensively developed in any part of the area, though in the vicinity of many of the towns small tracts are devoted to special crops. Apples are grown more extensively than other tree fruits, but these are raised only in small home orchards, there being no commercial orchards in the area. In 1909 Clark and Marathon Counties produced a total of 33,824 bushels of apples. Most home orchards are found on the Kennan silt loam and well drained Colby silt loam, though there are numerous farms upon which no apple trees are found. Strawberries are raised in all parts of the area for home use chiefly. Raspberries and black berries grow wild throughout the survey and can be profitably rasied commercially, but this line has not been taken up to any extent.

Stock Raising.—The raising of beef cattle has not reached any extensive proportions in this part of Wisconsin, although on many farms some stock is fattened for market. Excellent pasture is afforded, especially on the heavier types of soil, and in addition to the profits derived from selling cattle, their grazing assists in the clearing of the new land, which is a very important factor. Beef cattle can be kept over winter with profit, and it is believed that they can be profitably fattened in all the counties. Horses are not extensively raised for the market, but many farmers raise their own work stock. Hogs are kept, chiefly in conjunction with dairying, but the number is not as great as in sections where corn is more sure to mature. Sheep are raised

even in smaller numbers than are hogs. Some poultry is kept on practically all the farms, and the products sold figure materially in the income from the farm. A few farmers keep bees, and some place small quantities of honey on the market each year.

The following table, compiled from the 1910 census, gives a fair idea of the distribution and value of live stock, poultry and bees.

Distribution and Value of Livestock

	Marathon	Clark	Taylor	Lincoln
Cattle:				
Number	59,089	54,481	13,630	9,112
Value	$1,180,617	$1,365,408	$291,367	$173,841
Horses:				
Number	11,866	11,071	2,803	2,398
Value	$1,337,972	$1,160,380	$320,291	$279,064
Hogs:				
Number	18,079	16,611	2,706	3,478
Value	$115,347	$128,181	$22,806	$23,938
Sheep:				
Number	24,232	12,400	1,730	3,882
Value	$64,012	$50,918	$4,775	$10,789
Poultry, all kinds:				
Number	149,799	128,474	34,027	31,562
Value	$57,211	$52,881	$14,655	$12,361
Colonies of bees:				
Number	2,066	2,166	329	538
Value	$9,046	$7,845	$1,534	$2,173

Dairying.—Dairying is the most important branch of agriculture followed at the present time in the area surveyed, and the one which gives the greatest promise of the most extensive growth as the undeveloped portions of the region are settled up. Animals of Holstein breeding are more plentiful than cattle of other breeds. While the majority are grades, the number of pure breds is quite rapidly increasing. Pure bred sires are

most commonly used and the standard is constantly being raised. In 1909 the value of dairy products for the whole area amounted to the sum of $2,434,290. At present the annual output doubtless exceeds $3,000,000. In 1913 there were 84 cheese factories and 17 creamies in Marathon County and 71 cheese factories and 24 creameries in Clark County. The cheese factories are constantly increasing in numbers, while the creameries are decreasing, especially in the older settled regions. The silo is in common use and the numbers are rapidly increasing.

The following table, compiled from the 1910 census and from the Wisconsin Dairy Statistics for 1913, gives the number of dairy cows in the various counties of the area and the number and distribution of cheese factories and creameries.

Status of Dairy Industry

	Marathon	Clark	Taylor	Lincoln
No. of dairy cows	30,430	32,300	7,745	4,642
Milk produced—gal.	7,950,379	9,960,135	1,363,665	964,843
Creameries:				
1910	29	33	11	4
1913	17	24	11	5
Cheese factories:				
1910	61	50	5	12
1913	84	71	5	13
Value of dairy products, excluding home use of milk and cream.	$883,816	$1,171,341	$240,383	$138,753

Total value of dairy products for entire area for year 1909 .... $2,434,290

Relation of Soils and Crops.—The question of the adaptation of soils to crops has not been given as much consideration in this region as in older sections of the country. It is generally recognized, however, that certain soils favor certain crops or class of crops as, for instance, that rye will do better on sandy soils than any other small grain. Greater success is possible in dairying on the silt loam soils than on the sandy lands, since the heavy types are much better adapted to grasses and clovers and corn than the light soils. Potatoes, beans, and buckwheat give good results on the sandy types.

Crop Rotations.—Various crop rotations are practiced within the area, but little careful study has been given to the selection of rotations best adapted to the individual types of soil. Many instances were observed where fields have been allowed to re-

main in grass, cut for hay for five to eight years. In other cases small grains have been grown for years upon the same field without the introduction of any legumes or intertilled crops. In the southern part of the area, on the silt loam soils where considerable corn is grown a rotation quite commonly consists of corn 1 year followed by oats or barley seeded to timothy and clover. Hay may be cut for 1 or 2 years and the field then pastured for a year or two, after which it is again plowed for corn. On the sandy soils a common rotation consists of rye 1 year, followed by clover, and this crop by potatoes, corn, or beans. Buckwheat may then be grown for 1 year.

Weeds.—The most important weed pests within the area are the Canada thistle and quack grass. The use of imported feed in the lumber camps is largely held responsible for the introduction of these weeds. In a number of places they are so abundant as to materially reduce yields in the fields they infest. Wild mustard is abundant in places.

Land Clearing.—In the opening up of new farms the clearing of the land is the first operation. In some sections stones are plantiful and their removal sometimes is as expensive as clearing of timber. This, however, is unusual. Usually a site is selected which seems best suited for the location of the farm buildings, and clearing goes on from this center. All brush, logs, and stumps may be removed from a small tract for cultivated crops, and a larger area simply cleared of brush and logs sufficiently to be seeded and pastured. The stumps can then be gradually removed, or cultivated crops grown between them. After a few years the hardwood stumps will decay and can be readily pulled or burned out. Stump-pulling machines, dynamite, and fire are used in removing the stumps. In many places fires have run through the cut-over country and cleared away most of the underbrush and old logs, so that the cost of preparing the land for the plow is greatly reduced.

Land Values

As shown by the census of 1910 the average value of farm property at that time was $21.67 per acre for Lincoln County, $23.31 per acre for Taylor County, $29.35 for Marathon County, and $34.68 per acre for Clark County. The increase in value during the decade from 1900 to 1910 was approximately 100 per

cent. The selling price of improved and unimproved land is variable, depending upon the character of the soil, topography, location, improvements, and merchantable timber. Some of the lightest sandy soils can be bought for $5.00 per acre. The best grade of cut-over land frequently brings 20 to 25 dollars per acre and most of the wild land without timber has a value between these limits. Hardwood-timber land has a selling value of 20 to 50 dollars per acre, depending upon its location, condition of the timber, and ease with which it can be gotten out. In the regions where farming is well developed, as in most sections of Clark County and much of Marathon County, land values are quite high, numerous well located and well kept farms having been sold for $100 or more per acre. Probably the majority of farms throughout the best developed farming communities would have a selling value of between 60 and 100 dollars per acre.

The following table, compiled from the 1910 cenus, shows the conditions as to size, state of improvement, value, and tenure of farms in the counties in the area surveyed.

Size, Improvement, Value, and Tenure of Farms

	Marathon	Clark	Taylor	Lincoln
Approximate land area, acres	994,560	779,520	634,240	577,280
Per cent of land area in farms	53.6	52.8	21.5	21.6
Per cent of total land area improved	18.5	29.5	4.3	5.7
Average size of all farms, acres	105	98	86	112
Per cent of farm land improved	34.6	36.9	24.8	26.8
Average improved land per farm, acres	36	36	21	30
Improved land in farms, acres:				
1910	184,153	151,891	33,892	33,549
1900	145,060	120,964	23,392	23,317
Average value per acre of farm property:				
1910	$29.35	$34.68	$23.31	$21.67
1900	14.29	19.57	10.88	10.57
Per cent of farms operated by owners	95.8	91.8	96.1	95.6

CLIMATE*

Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season and the amount and distribution of the rainfall. Any one of these factors may determine the type of agriculture which can be practiced to best advantage.

The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation ranging from 28 to 34 inches, while the mean for the state as a whole is 31 inches.

The local distribution of rainfall varies, however, from year to year in different sections. The variation is caused by the movement of cyclonic storms. The average rainfall for the entire state during the driest year was 21.4 inches and for the wettest year 37 inches.

Of equal importance in agriculture to the total rainfall is its seaosnal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall occurs in May, June, July and August, and nearly 70 per cent from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9. The small winter precipitation in Wisconsin, mainly in the form of snow, causes virtually no erosion or leaching of fertility from the soil. The average rainfall for the state during the winter is 3.9 inches, during the spring 8.3 inches, during the summer 11.4 inches, and during the autumn 7.4 inches.

The following table gives the mean precipitation at three points within the survey. Records for Madison are also given for purposes of comparing the area with southern Wisconsin.

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*For further information see Wisconsin Expt. Sta. Bul. 223.

Mean Monthly, Seasonal, and Annual Precipitation

	Wausau	Neillsville	Medford	Madison
	inches	inches	inches	inches
December	1.26	1.63	1.29	1.72
January	1.16	1.11	0.96	1.63
February	1.11	1.42	1.09	1.50
Winter	3.53	4.16	3.34	4.85
March	1.84	2.14	1.45	2.08
April	2.58	2.84	2.26	2.54
May	4.11	4.24	4.26	3.66
Spring	8.53	9.22	7.97	8.28
June	4.18	4.91	5.10	4.01
July	4.19	3.79	4.09	3.80
August	3.58	3.28	3.52	3.15
Summer	11.95	11.98	12.71	10.96
September	3.70	3.77	4.05	3.08
October	3.02	2.92	3.41	2.32
November	1.70	1.74	1.57	1.76
Fall	8.42	8.43	9.03	7.16
Year	32.43	33.97	33.05	31.25

Average for three stations in area surveyed.......................... 33.15 inches.
The average snowfall at Neillsville is................................. 40.70 "

It will be seen from the above table that the mean annual precipitation of the area surveyed is 33.15 inches and that the greater part of this occurs during the growing season when most needed. It will be noted that for the months from April to October inclusive there is an average monthly rainfall of over 2.25 inches and that for the months from May to September, inclusive, the rainfall is over 3 inches for each month.

The northern portion of the area surveyed occupies part of

the southern slope of the Northern Highland, and the southern portion of the area occupies the northern extremity of the Southern Highland. These highlands are two of the eight climatic provinces of Wisconsin. The greater portion of the area has an elevation of from 1,000 to 1,600 feet above sea level. The main streams traversing this region have a general course from north to south. This section is characterized by cold winters and warm summer days with rather cool nights. In the northern part of the survey the average growing season for corn is about 110 days, while in the southern part is about 130 days. Clark and Marathon Counties have a growing season of nearly the same length as Juneau, northern St. Croix, northern Trempealeau, and northern Sauk Counties.

The following table gives the average dates of the last killing frosts in the spring and the first in the fall at various stations within the survey and also at Madison, Wisconsin.

Average Dates of Killing Frosts

Station	Length of record (years)	Last killing frost in spring*	First killing frost in fall*	Elevation of station above sea level—feet
Wausau	14	May 30	Sept. 22	1,212
Neillsville	21	May 23	Sept. 20	996
Medford	19	June 3	Sept. 12	1,420
Madison	31	April 22	Oct. 18	974

*Aggregate.

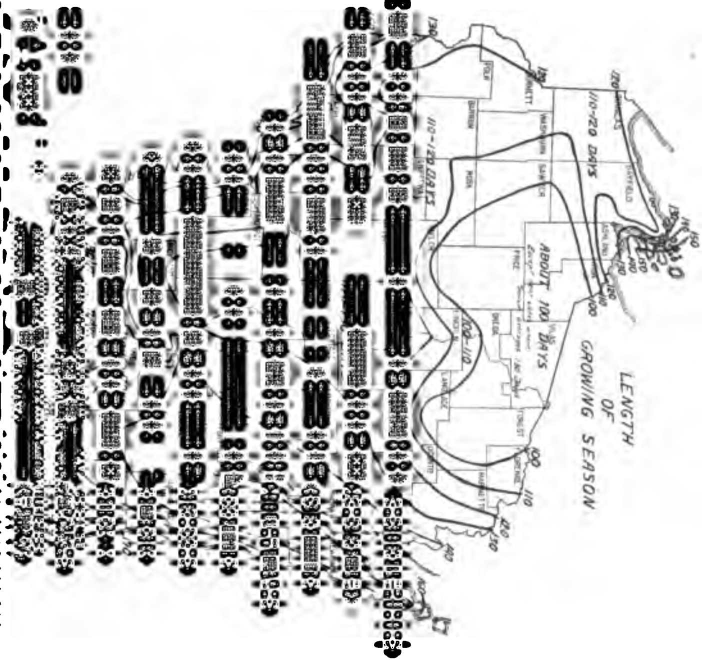
From this table it will be observed that the average date of the first killing frost in the fall at the different stations ranges from Sept. 12 to Sept. 22, and of the last killing frost in the spring from May 23 to June 3. In the extreme northern part of the area light summer frost may occur, but these are seldom so severe as to injure growing crops. As the timber is cleared away, the land more thoroughly drained, and more of the land put under cultivation the growing season gradually lengthens.

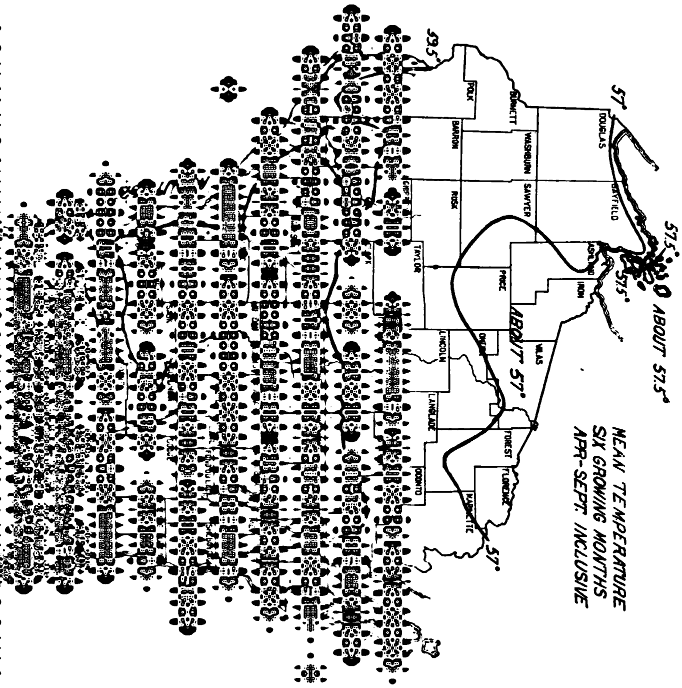
The table following gives the mean monthly, seasonal, and annual temperature as recorded at three stations within the area. Records for Madison are also given so temperatures may becompared with those prevailing in the southern part of the state.

Mean Monthly, Seasonal, and Annual Temperature

	Wausau	Neillsville	Medford	Madison
	F°	F°	F°	F°
Elevation of station	1,212 ft.	996 ft.	1,420 ft.	974 ft.
December	18.3	19.1	17.9	22.8
January	14.8	13.1	12.9	16.9
February	14.9	13.8	13.6	18.7
Winter	16.0	15.3	14.8	19.5
March	27.6	27.8	26.2	30.4
April	43.0	44.2	42.1	45.6
May	55.4	55.5	53.9	57.6
Spring	42.0	42.5	40.7	44.5
June	64.6	65.9	65.1	67.3
July	68.3	69.8	68.8	72.0
August	66.5	67.1	67.1	69.7
Summer	66.5	67.6	67.1	69.7
September	59.2	59.4	59.7	62.3
October	46.9	46.9	46.0	50.0
November	32.3	31.3	30.2	35.1
Fall	46.1	42.5	45.3	49.1
Year	42.6	42.8	42.0	45.7

It will be seen from this table that the mean summer temperature at the different stations ranges from 66.5° to 67.6° and that the mean annual temperature for the three stations is 42.4° F. There are only a few days during summer when the temperature rises above 90°, and it seldom reaches 100°. There are also only a few days during winter when it falls lower than 20° below zero.


LENGTH
OF
GROWING SEASON
ABOUT 100 DAYS
110-120 DAYS
110-120 DAYS
100-110


MEAN TEMPERATURE
SIX GROWING MONTHS
APR-SEPT. INCLUSIVE
ABOUT 57°
ABOUT 57.5°

While the growing season for corn, potatoes, and other crops affected by light frosts is relatively short in the extreme northern portion of the area, the growing season for small grains, grass and root crops is more nearly equal to that in the southern part of the state. The spring is a little later, but grass and hardy vegetables grow nearly if not quite as late in the fall as they do in southern Wisconsin. The climate is healthful, and while the winters are long and severe, the summers are especially delightful. The water supply is abundant and of good quality. These factors, together with the large areas of excellent unimproved agricultural land, especially in Taylor and Lincoln Counties, are instrumental in attracting large numbers of new settlers to the region.

SUMMARY

The area covered by the reconnoissance soil survey of the South Part of North Central Wisconsin includes four counties—Marathon, Clark, Taylor, and Lincoln, and embraces a total area of 4,865 square miles or 3,113,600 acres, located just north of the center of the state. The surface features of the northern and eastern portions of the area are characteristic of a glacial region and the topography ranges from level to rough and broken, but the remainder of the survey has a surface much older geologically, and the topography is more mature. Slopes are long and gentle and but few lakes and swamps are found. Elevations range from about 784 feet to 1,940 feet above sea level. The major portion of the region ranges from 1,000 to 1,600 feet above sea level. The streams traversing the region afford much potential water power. The first mill in Marathon County was established in 1840. In 1855 German immigrants started to come into the region and agricultural development may be said to date from about this time. Lumbering was the most important industry for a long period and is still important in Taylor and Lincoln Counties. Agricultural operations were not well under way until the seventies and farming could not be considered of much importance before the eighties, when the southern portion of the region surveyed, in Clark and parts of Marathon Counties, were rapidly being settled and put under cultivation. Throughout the northern part of the area lumbering is still an important industry, but agriculture is rapidly developing wherever the timber has been removed and the land is of good quality.

Three important railway systems and several smaller lines traverse this region, providing excellent transportation facilities and connecting this section with most of the largest and most important markets of the Middle West.

The winters of this region are long and cold, but the summers are delightful, and all crops make rapid growth. Excellent water is available in all parts of the area, and the region is a healthful one.

Within the region surveyed all stages of agricultural development are represented. In the southern portion of the survey, in Clark and Marathon Counties, much of the land is highly improved with values ranging from 60 to over 100 dollars per

acre, while in Taylor and Lincoln Counties there are still numerous extensive tracts of virgin hardwood forest. Cut-over land can be bought for $5 per acre and up, depending upon the character of the soil and location. The lightest sandy soils, originally covered with pine, have a low agricultural value, but the cut-over hardwood regions include much excellent land which offers exceptional opportunities for agricultural development. This land can be bought for from 10 to 25 dollars per acre. The chief crops grown at present are oats, hay, corn, potatoes, barley, rye, wheat, peas, and some buckwheat, with small patches of truck crops close to the towns. As reported in the census of 1910 Marathon County had 53.6% of its entire land area in farms, and 18.5% of the total land area was improved. In Clark County 52.8% was in farms and 29.5% of the total was improved. In Taylor and Lincoln Counties only 4.3% respectively of the total area was improved. During the past decade development has been rapid so that at the present time there is a larger percentage of improved land in all of these counties. During the decade 1900 to 1910 the average value of farm property practically doubled. The type of farming chiefly followed at present consists of general farming in conjunction with dairying. In 1913 there were 173 cheese factories and 57 creameries in the area. For 1909 the output of dairying products for the area amounted to $2,434,000, and the total for Clark County alone was $1,171,000.

The soil material covering the region has been derived largely from the underlying geological formations of which there are several. Twelve soil series and 30 soil types, excluding peat, have been recognized and mapped in this survey.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the managment of the different types of soil mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

E. A. BIRGE, Director. W. O. HOTCHKISS, State Geologist.
A. R. WHITSON, In Charge, Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean.

BULLETIN NO. 52--B SOIL SERIES NO. 17

SOIL SURVEY

OF

WOOD COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, GUY CONREY, W. C. BOARDMAN AND CLINTON B. POST

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS,
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

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Wisconsin Geological and Natural History Survey

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STAFF OF SURVEY

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INTRODUCTION

Before the greatest success in agriculture can be reached it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful stuay of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped. but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made. to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by lo-

cating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A course sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may

be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.

Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.

Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.

Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Sandy clay.—Less than 20% silt.

Soils Containing over 50% of Silt and Clay.

Loam.—Less than 20% clay, and less than 50% silt.

Silt loam.—Less than 20% clay, and over 50% silt.

Clay loam.—Between 20 and 30% clay, and over 50% silt.

Silty clay loam.—Between 20 and 30% clay, and over 50% silt.

Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a *soil series.* It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for examples, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand

and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

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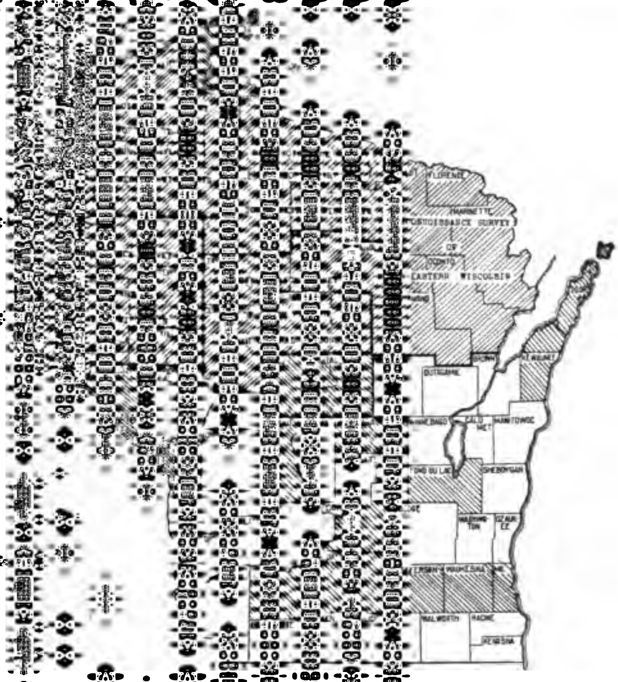

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The surface of the area falls naturally into two topographic divisions and the line separating them runs nearly parallel with, but somewhat to the north of, the Green Bay & Western Railroad, which crosses the county from the east to west, passing through Grand Rapids, Elm Lake, Dexterville. The region to the north of this line comprising more than half of the county, consists of an undulating or nearly level to rolling country throughout which the soils are heavy and of good to excellent quality for agricultural purposes. Many communities here are as well improved and as highly developed as the best farming regions of southern Wisconsin. The most conspicuous features in this region are the Marshfield Moraine south and southeast of Marshfield, Powers Bluff, southwest of Arpin, and Cory Mounds in the west central part of the county. To the south of this line the country consists of nearly level sand plains, having a gradual rise from the south to the north. Projecting through the floor of this plain and rising to elevations from 20 to over 100 feet are a few sandstone and quartzite hills, which form the most conspicuous feature of the landscape. The country in general consists of extensive sand flats, on which in a few instances low dunes have been formed, and which give way in the southern and southwestern parts of the county to large stretches of marsh often dotted with innumerable small sand islands only 1 or 2 feet above the level of the lowlands. The fertility of the sands is low and agricultural development limited. On the marshes hay is frequently grown. The cranberry industry has been developed on the marsh land to considerable proportions. In numerous places large drainage projects have been constructed and efforts are being made to develop the region agriculturally. In general this region is one in which the land has a much lower value than is the case throughout the northern part of the county.

In the northern two-thirds of the county, which is largely covered by debris from early ice sheets, the topography is much more mature than in the portions of the state covered by the Late Wisconsin Ice Sheet. In most cases slopes are long and gentle, there are no lakes, and comparatively few swamps. The elevation of railway stations will give an idea of the average elevation of the region. Vesper has an elevation above sea level of 1090 feet, Arpin 1149 feet, Marshfield 1283 feet, and Auburndale 1213 feet. In the highest portions of the Marshfield Moraine

an elevation of 100 to 150 feet above the surrounding lowland is reached, though no topographic survey has been made of this region. Powers Bluff reaches an estimated elevation of 300 to 400 feet above the surrounding lowland, and this is doubtless the highest point in the area.

The sand flats of southern Wood County, which are largely of alluvial origin, are considerably lower than the north portion of the county. The elevation at Port Edwards at the railroad station is 969 feet; at Nekoosa 959 feet, Dexterville 977, and at Babcock 977 feet. It will thus be seen that there is a difference in elevation of from 200 to 300 feet between the sand and marsh region of the southern part of the area and the region of heavy soils in the northern part of the county.

The drainage of most of the county is into the Wisconsin River, which crosses the eastern part of the area and receives directly nearly all drainage waters from the eastern two tiers of townships. From the east the largest streams entering it are Buena Vista Creek, Duck Creek, and Ten Mile Creek. A few small streams join it from the west. Nealy all of the remainder of the area drains first into the Yellow River which traverses the western portion of the county from north to south, and joins the Wisconsin River at Necedah in Juneau County to the south. The Little Eau Plaine River in Marathon County receives a small amount of drainage from the extreme northern side of the county. This stream joins the Wisconsin River at Dancy. The East Fork of the Black River receives drainage water from about two townships in the west central part of the county. This stream joins the Black River in southern Clarke County, and then flows into the Mississippi River.

The pioneer in the lumber business along the Wisconsin River in this region was Daniel Whitney who erected the first saw mill on the present site of Nekoosa in 1831. In 1836 a strip of country 3 miles on each side of the river, to 40 miles north of this point was given up to the lumbermen by the Indians. In 1838 the first mill was erected at Grand Rapids. In 1844 Portage County, which was originally included Wood, was organized. In 1848 title to all lands was taken from the Indians and the country opened up for settlement. In 1856 Wood County was separated from Portage. Grand Rapids was incoporated in 1869. The first settlement in Marshfield was made in 1871. Dexterville

was settled in 1852 and Pittsville in 1858. Settlements were made in the southern portion of the county earlier than in the northern, chiefly because pine was the predominant timber growth while in the north the pine was usually mixed in with hardwood. Lumbering was the chief industry for a long period after the first settlements. The old Wisconsin Central Railroad (now the Soo Line) was built through the county to Marshfield in 1871. The Wisconsin Valley Railroad (now the C. M. & St. P. Ry.) was built through the county in 1873.

Among the early settlers many came from the older states of Illinois, Ohio, New York, and also from Canada. Later many foreigners were attracted to this region and among these the Germans, Norwegians, and Swedes were the most numerous. People of German descent are probably the most numerous at present. All portions of the county are now settled, but the extent of development and diversity of population is variable, following largely the quality of the soil. The southern part of the county is for the most part thinly settled and only a comparatively small percentage of the land is improved, while throughout the northern part of the area the region is well settled and the land highly improved.

Grand Rapids, with a population of about 8000, is the county seat and the largest city in the area. It is a distributing and railroad center of importance, four separate railway lines entering the city. Extensive water power is developed here from the rapids in the Wisconsin River and one of the chief uses of this power is in operating an extensive paper mill at this point. Other extensive power developments and paper mills are located within the area at Nekoosa, Port Edwards, and Biron. Marshfield, the second city of importance, has a population of 6000 and is located in the center of a highly developed agricultural region. Nekoosa, a paper mill town, has a population of about 1200. Among other towns in the area are Pittsville, Babcock, Dexterville, Auburndale, Milladore, Vesper, Arpin, and Rudolph.

The county is well supplied with railroads. A line of the C. M. & St. P. Ry. crosses the area from north to south passing through Rudolph, Grand Rapids, Nekoosa, and Babcock. A branch extends from Babcock to Pittsville, Vesper, Progress, and Lindsey. A branch of the C. N. W. from Fond du Lac to Marshfield passes through Grand Rapids, Vesper, Arpin, and

Marshfield where it joins another branch which again joins the main line at Merrillan Junction. The Soo Line (Old Wisconsin Central) crosses the northern part of the county passing through Milladore, Auburndale, and Marshfield, with a branch extending from Marshfield to Grand Rapids and Nekoosa. The Green Bay and Wesetern crosses from east to west, running through Grand Rapids, Elm Lake, and Dexterville. From Marshfield to Chicago it is 284 miles over the Soo Line, and from Grand Rapids toChicago over the C. M. & St. P. Ry. it is 270 miles.

The numerous towns within the county furnish a market for considerable farm produce, but the greater proportion is shipped to outside points. A large proportion of the income from farms comes from the sale of dairy products, chiefly butter and cheese, much of which goes to Chicago and eastern and southern cities. Practically all fat stock sold is shipped to Chicago. Hay is frequently shipped to Milwaukee.

The wagon roads throughout the southern one-third of the county are sandy. In places there are deposits of clay which could be utilized in improving the roads and this is being done in some instances. In the northern portion of the county the soil is heavy and where graded up roads are generally good. With continued heavy rains and when the frost is coming out roads are often heavy. Under the State Aid Highway Law many miles of improved road are being built each year and it is the plan to ultimately have such roads in every community.

Rural mail routes reach all parts of the area and the telephone is in common use in farm homes. Rural schools are found in every community and most of the school buildings are modern structures and kept in good repair.

SOILS*

The region covered by the present survey, in common with a considerable area extending over several adjoining counties in central Wisconsin, owes the general character of its surface to at

* For a full discussion of the geology of this region see Bul. XVI, Wis. Geol. & Nat. Hist. Survey, by Dr. Samuel Weidman, on Geology of North Central Wisconsin. Practically all Geological data used in the Soil Survey report of Wood Co. has been taken from this Geological report.

least four distinct processes of formation. These may be termed glacial, residual, alluvial, and probably loessial. To these may be added the accumulation and decay of large amounts of vegetable matter in low places and the formation of Peat.

Glacial formations cover approximately 60 per cent of the county and these formations were deposited at a much earlier date than the glacial debris covering northern and eastern Wisconsin. Geologically it is called the Pre-Wisconsin Drift, in which three periods of glaciation have been recognized. Two of these are found in Wood County. The glacial region is confined to the country north of the Green Bay & Western Ry. and covers most of the north two-thirds of the county with the exception of a narrow belt along the eastern border. The greater part of this region is within the region where the First Drift or earliest drift appears as the surface formation. About one township in the extreme northwestern corner of the county is covered by the Second Drift. Marshfield is situated on this area. Marking the southern border of the Second Drift is a pronounced range of hills known as the Marshfield Moraine.

The topography over the glaciated region varies from level to rolling, and in a few places hilly, though most of the region is characterized by long gentle slopes. There are comparatively few stones found upon the surface and most of the material consists of a silt loam or clay loam in texture. One of the most important characteristics of this old drift is the heavy compact subsoil and the fact that this subsoil is strongly mottled. This material has weathered to a much greater extent than the Late Wisconsin Drift, the topography is much more mature, and no lakes and a few peat marshes are found.

The portion of the area which is considered to be largely of residual origin occurs along the eastern border of the county in Milladore, Sherry, Sigel, and Rudolph Townships. The material forming the soil, and more especially the subsoil, has been derived from the weathering of the underlying crystalline rocks. Angular rock fragments frequently are found scattered over the surface, and a few glacial bowlders also occur. It seems probable that the region was traversed by an ice sheet, but its influence was very slight and does not seem to have influenced the region to any appreciable extent. This region is mostly gently rolling, with long slopes and broad rounded elevations.

In the southern half of the county there are a few areas over which the soil is also residual, but here it has been derived from Potsdam sandstone instead of from crystalline rocks.

The alluvial formations are confined to the southern one-third of the county, mostly south of Grand Rapids and the Green Bay and Western Railroad. This region consists of a series of sand flats associated with which, west of the Wisconsin River, there are extensive marshes. In some of these marshes there are numerous small sand islands only 1 or 2 feet higher than the level of the marshland. The greater part of the material throughout this sandy region is of alluvial origin, having been deposited by enlarged streams during pre-glacial or inter-glacial times. In a few places the underlying Potsdam sandstone comes to the surface and gives rise to a residual sandy soil. Where a shaly phase appears with the sandstone the residual material is considerably heavier.

Over most of the county north of the Green Bay & Western Railroad there appears a covering of extremely silty material which has some of the characteristice of loess and some authorities indicate that this may have been deposited by wind action. This loessial blanket extends over the residual area as well as over the glaciated region, but it is usually thin—from a few inches to two or three feet in thickness.

Throughout most of the northern half of the county and over isolated areas in the southern portion crystalline rocks make up the surface rock formation. These are, for the most part, granite. In the vicinity of Milladore, Pittsville, Grand Rapids, an at a few other points gneiss and schist appear as the surface rock. In the vicinity of Arpin and Powers Bluff conglomerate and quartzite occur. In Milladore and Sherry Townships and at a few other points diorite-gabbro appears as the surface rock. Outcrops of these various rocks are frequently seen.

Over most of the southern part of the county and along the western border Potsdam sandstone appears as the surface rock. In a few places the sandstone outcrops, though in most cases, especially near the Wisconsin River, it is deeply buried by deposits of alluvial sand.

All rock formations have contributed to a greater of less extent in the formation of the soils of this region. A much larger proportion of the soil material has come from the crystalline

rocks than from the sandstone. Through glacial action the crystalline rock debris has been carried over onto sandstone over considerable areas, especially in the western portion of the county. In other places small patches of sandstone occur over the crystalline rocks in the northern and northeastern parts of the county.

Ten soil series and 18 soil types, exclusive of Peat and Muck, were recognized and mapped in this survey.

The Colby series comprises light colored timbered upland soils chiefly within the region of Pre-Wisconsin glaciation where the material has come largely from crystalline rock formations and where the subsoils are compact, of impervious nature, and strongly mottled. This is the most extensive series mapped and is the predominating soil throughout the northern two-thirds of the county.

The Marathon series comprises light colored upland timbered soils where the material is largely residual, having been derived from the weathering of the underlying crystalline rocks. It is confined to the northeastern portion of the county. It is of much smaller extent than the Colby soils.

The Vesper series is characterized by heavy surface soils of glacial or loessial origin, underlain by sand or bed rock at an average depth of from 18 to 24 inches. The underlying rock is usually sandstone, though in some cases it was found to be crystalline rocks. The surface is usually level and the natural drainage is deficient over the typical soil.

The Kennan series includes light colored upland timbered glaciated soils derived from crystalline rock material. It differs from the Colby by having a more open subsoil and by not being mottled.

The Whitman series includes dark brown to black lowlying soils which occupy a position comparable with the Clyde series, but which occur in a non-calcareous region and have been derived largely from crystalline rocks. They may occur as depressions or poorly drained areas in the upland or as alluvial bottoms along stream courses throughout the same region. The series is of limited extent in the present survey. It is most closely associated with Colby and Marathon soils.

The Boone series includes light colored upland soils which

have been derived from the weathering of Potsdam sandstone. The soils are for the most part very sandy.

The Plainfield series includes light colored timbered soils of alluvial origin where the parent material has come largely from sandstone formations. This series is found extensively in the southern third of Wood County in the valleys of the Wisconsin and Yellow Rivers. Most of the soils mapped in this series in the present area are of a very sandy nature. They occur chiefly as terraces and are not subject to overflow.

The Dunning series consists of low-lying dark colored or black soils which have a position comparable with that of the Clyde soils, but the Dunning differs from the Clyde by being in a non-calcareous region, and by having been derived largely from sandstone material. It is confined to the southern part of the area.

The Genesee series consists of light to dark brown alluvial soils occupying first bottom lands which are subject to overflow. The parent material came largely from reworked glacial debris.

The Antigo series includes light colored soils of alluvial origin where the parent material has been derived largely from crystalline rocks and now occurs as outwash plains or river terraces above present flood flow.

Peat, Shallow Peat, and Muck consist of decaying vegetable matter with which there is incorporated varying amounts of mineral matter, and which extends to varying depths.

Undifferentiated sand and marsh consists of marsh land and low flat sand islands so intricately associated that a separation was impossible on the scale used.

Area of different types

Soil	Acres	Per cent
Colby silt loam	109,440	25.9
Rolling phase	24,884	
Vesper silt loam	60,736	15.0
Rolling phase	16,640	
Peat	49,920	13.1
Shallow phase	17,856	
Plainfield sand	60,224	11.6
Whitman silt loam	42,112	8.1
Sands and peat (undifferentiated)	28,736	5.6
Dunning sand	16,640	3.2
Plainfield fine sand	15,936	3.1
Boone fine sand	14,528	2.8
Vesper fine sandy loam	8,896	1.7
Rolling phase	8,896	1.7
Marathon silt loam	8,000	1.6
Dunning fine sandy loam	7,424	1.4
Genesee fine sandy loam	7,000	1.4
Marathon fine sandy loam	6,208	1.2
Genesee silt loam	5,312	1.0
Dunning fine sand	3,840	.7
Plainfield sandy loam	2,304	.4
Antigo fine sandy loam	1,216	.2
Muck	960	.2
Kennan fine silt loam	512	.1
Total	517,760	

CHAPTER II.

GROUP OF HEAVY SOILS

COLBY SILT LOAM

Extent and distribution.—The Colby silt loam is the most extensive type mapped. It occupies a large part of the northern half of the county. It occurs here in areas unbroken except for an occasional hill or ridge occupied by the rolling phase and small, narrow areas of Whitman silt loam along stream courses. Within the Vesper soils the Colby silt loam is mapped in a few areas where the depth to the sandy layer is so great as to warrant its separation.

Description.—The surface soil of the typical Colby silt loam is a grayish-brown silt loam, 8 to 10 inches in depth, very smooth to the feel, and carrying little or no coarse material. When wet it is more yellowish brown in color and rather sticky, though it does not polish on the auger. A few bowlders occur scattered over the surface.

The subsoil is a mottled yellow, drab, brown, and blue silt loam, grading into a heavy, tenacious, sticky silty clay loam at depths of 15 to 18 inches. This mottled silty clay generally extends to a depth greater than 3 feet. The stiff, close character of the subsoil makes it almost impervious to water, and this stratum is locally called "hard-pan." The mottled color of the subsoil is characteristic of the type. It is not uncommon for the mottlings to come within 2 or 3 inches of the surface.

The type as a whole is remarkably uniform, but the lower subsoil is subject to some variation. In the vicinity of the Marshfield Moraine a layer of gravelly, gritty silty clay loam occurs at varying depths. At greater distances from the moraine, both east and west, the mottled silty material becomes deeper and in general extends to a depth greater than 3 feet. In the northern part of Richfield Town residual material from sandstone occurs at depths

of 36 to 40 inches, while farther south, in the same town, the sandstone comes closer to the surface. Where the sandy material is within 20 inches or less of the surface the soil is separated as the Vesper silt loam. There is an increasing percentage of very fine sand in both surface soil and subsoil as the Vesper soils are approached, the texture being a silty loam in some places. The sandstone stratum does not extend as far north in the eastern part of the county as in the western, but there occasional isolated outcrops within 3 or 4 miles of the north county line, as just south of the railroad tracks, a few rods from Auburndale, in the northeast quarter of section 27.

A variation in the type occurs in the northern two-thirds of Rudolph Town and in a small area north of Milladore. The surface soil here is a gray to yellowish-brown silt loam, 8 to 10 inches deep, friable in structure and smooth to the feel. The subsoil consists of a brownish-yellow silt loam grading at 18 to 20 inches into a mottled silty clay loam, very heavy, tenacious, and sticky. The mottlings are yellow, brown, and gray. The subsoil below the depth of 30 inches may contain considerable residual material, although the mottled subsoil quite commonly continues to a depth greater than 3 feet. The topography in general is gently undulating to undulating. Because of the heavy, tenacious character of the subsoil the land is nearly always poorly drained, especially in the more nearly level areas, and crop production is more often limited on this account than for any other reason.

Topography and drainage.—The topography of the Colby silt loam ranges from level to gently undulating. The region occupied by this type is characterized by long, gentle swells and broad, nearly flat areas. Because of the level topography and impervious subsoil, the type as a whole is poorly drained. The drainage of the areas of Colby silt loam is divided. In the northern part of the county it is toward the north, into the Little Eau Plaine River. In the central part of the county Mill Creek and its tributaries drain to the east into Portage County. In the western part the Yellow River drains to the southwest into Juneau County, cutting through the Marshfield Moraine in section 26, township 25 north, range 2 east. The line of the Minneapolis, St. Paul & Sault Ste. Marie Railway follows approximately the divide between the first two drainage systems, and the Chicago and North Western Railway the divide between the second and

third. The most extensive unbroken areas of Colby silt loam, with a typical level to very gently rolling topography, occupy these divides, as in sections 27, 32, 33, and 34, Milladore Town; sections 14, 15, and 16, Auburndale Town; section 17, Lincoln Town; and along the line between Marshfield and Richfield Towns. In some instances the surface is that of a long, gentle slope rather than strictly level. These areas occupy the same physiographic position as the broad prairies of southern Wisconsin. Adjacent to intermittent drainage courses and where the Whitman silt loam occurs the Colby silt loam is commonly quite level and wet. Some of the wettest areas are indicated by marsh symbols.

Origin.—The Colby silt loam is confined to the region covered by the early periods of glaciation. The glacial material has come from crystalline rocks and has been weathered to a much greater extent than material from the late Wisconsin drift. The extreme silty surface soil appears to be part of the blanket of loesslike material which covers much of the State. In a few places the deep subsoil is residual from the underlying crystalline rocks. Both surface soil and subsoil show varying degrees of acidity. The material is often strongly acid.

Native vegetation.—The original timber growth on the Colby silt loam consisted of mixed hardwoods, maple, oak, basswood, elm, birch, large white pine, and some hemlock. The second growth is poplar. Most of the merchantable timber has been cut, but a considerable acreage still supports some valuable timber.

Present agricultural development.—Less than 25 per cent of this type is under cultivation. Adjacent to the railroads the land is fairly well cleared, but in many sections the more remote tracts are still in brush and timber. Away from the villages there are large areas that have not been cleared at all except in small patches near the roads. Before clearing the land seems wet, but under cultivation the surface water is removed with more rapidity. Even then, however, the drainage is not adequate in many cases, because of the slow movement of water downward through the soil. This causes the ground to remain very wet for some time after rains and crops do not make their best development.. The soil is cold and backward in the spring. The nearly level and the very gently undulating areas have about equally good under-

drainage, but the gently undulating land is the more desirable from the standpoint of surface-drainage possibilities.

Where fair drainage can be effected this soil gives good yields. It is especially well adapted to grasses, clover making a remarkably good growth. Oats, barley, rye, and other grains produce large yields, but have some tendency to lodge. Corn for ensilage does fairly well and the crop often matures. Root crops give heavy yields.

Selling values of improved land of the typical Colby silt loam range from $40 to $100 an acre.

In the cultivation of this soil the fields should be plowed in narrow lands, so that the dead furrows will assist in carying off the surface wate. Practically all the land would be improved by tile drainage. Because of the impervious nature of the subsoil the lines of tile, to be most effective, must be placed closer together than on any other soils in Wisconsin. The type requires careful cultivation with heavy stock and tools. It should be worked only when moisture conditions are most favorable. A mellow seed bed can then be readily obtained. The plowing under of green manuring crops, preferably the legumes, improves the physical character of the soil and increases the supply of origanic matter. As the soil is acid, and frequently strongly acid, the use of lime is necessary if alfalfa is to be grown. On new land red clover does very well in spite of the acidity, because of the high virgin productiveness, but on old fields the use of lime would be beneficial to red clover and also to general farm crops. Because of the rather high cost of correcting the acidity on this type it may be advisable to grow such legumes as alsike clover and soy beans, which do well on acid soils, in place of red clover and alfalfa.*

COLBY SILT LOAM, ROLLING PHASE.

Extent and distribution.—The rolling phase of the Colby silt loam occurs in the northern half of the county in irregular areas associated with the typical Colby silt loam. It has a more rolling surface. In a few areas mapped, such as those adjacent to Powers Bluff and Cary Mounds, the topography is very rolling and the phase much better drained than the typical

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* For chemical composition of this soil see page 33.

soil. The rougher areas containing rock outcrops are indicated on the map by symbols.

Description.—The surface soil of the Colby silt loam, rolling phase, is a gray to brown, friable silt lam, 8 to 10 inches deep, very smooth to the feel and comparatively low in origanic matter. The virgin soil often has a dark-brown color in the surface one or two inches, due to an accumulation of organic matter. An occasional bowlder occurs on the surface. The subsoil consists of a grayish-brown silt loam mottled below 12 inches with yellow, brown, and gray. Below 15 inches the subsoil becomes a strongly mottled, heavy silt loam or silty clay loam. It is very compact, tenacious, and impervious to water.

On the whole the surface material is remarkably uniform, but the lower subsoil is variable. Prevailingly a mottled silty clay loam extends to a depth greater than 3 feet, but occasionally within 30 inches a gravelly clay loam of glacial origin occurs. Reddish, gritty clay loam or clay, of residual origin, is also encountered in places. In some of the more rolling areas there is very slight mottling and in some places almost none. In places here the soil resembles very much the Kennan silt loam, rolling phase, except that the gravelly layer is lacking.

Topography and drainage.—The phase has a very gently rolling to rolling topography. In the more rolling situations some small areas are too steep for general agriculture, being better adapted to use as pasture. The natural surface drainage is in general good, but some of the more gentle slopes would doubtless be benefited by tile drainage. The rolling phase is separated chiefly to indicate those areas which have slope enough to insure good surface drainage. Only in the more rolling areas is erosion serious, although it demands some attention on the gently rolling to rolling tracts.

Origin.—In origin the rolling phase of the Colby silt loam is practically the same as the typical soil having been derived through early glacial action from crystalline rocks, and being covered with a mantle of loess-like material, the exact origin of which seems to be still in question. Like the typical soil, the phase is quite acid.

Native vegetation.—The original timber growth on this soil consisted of mixed hardwoods, some hemlock, and large white

pine. All of the pine and much of the best hardwood has been removed.

Present agricultural development.—A large percentage of this phase is under cultivation. Owing to its better drainage it has in general been taken up before the more level soils. It is very productive. Grains,such as oats, rye, and barley do well and occupy a large proportion of the total cultivated area. Corn ripens on this soil better than on some of the other types. Some of the best corn observed in the fall of 1915 was on one of the more rolling areas of this soil, where air drainage had prevented early frosts. The phase makes an excellent general-farming and dairying soil, since it is especially well adapted to grasses and clover. Some of the most highly developed farming communities in the county are on this class of land.

The suggestions made for the improvement of the typical soil apply also to this phase, except in regard to the drainage conditions. Because of the better drainage the phase can be cultivated earlier in the spring. It is somewhat easier to handle and on the whole is more desirable soil.

Land values on the rolling phase of the Spencer silt loam range from $50 to over $100 an acre, depending upon the location, buildings, topography, and other factors. *

VESPER SILT LOAM

Extent and distribution.—The Vesper silt loam is the second soil type in the county in importance from the standpoint of area covered. It occupies a total area of over 60,000 acres not including the rolling phase which covers an additional 16,000 acres. The Vesper silt loam occurs as a broad, rather irregular belt which extends nearly across the center of the county from east to west. The towns of Vesper, Pittsville, Veedum, Progress and Lindsay are largely surrounded by this soil. This Vesper area is bounded on the south chiefly by the sandy soils of southern Wood County, and on the north by the heavy soils of the Colby series.

Description.—The surface soil of the Vesper silt loam, extending to a depth of 8 to 10 inches, is a gray to grayish-brown silty loam to silt loam, containing in some places a small amount of fine and very fine sand. It is not uncommon for the surface soil

* For chemical composition of this soil see page 33.

to show slight mottlings. Fragments of sandstone occur occasionally on the surface over areas of small extent, but most of the type is stone free. The subsoil to a depth of 20 to 24 inches is a very compact silt loam, mottled drab, yellow, and brown. It passes at a depth of about 2 feet either into a drab or yellow, fine or medium sand or into more or less decomposed sandstone. Above the sand or sandstone the subsoil for a few inches is a heavy sandy loam or gritty clay loam.

The character and depth of the subsoil material are variable. Their condition over a large part of this type is probably well shown in the clay pit at the brick and tile works at Vesper. Beneath a 2 foot layer of more or less mottled silt loam there occurs about two feet of decomposing sandstone and sand. This is underlain by a red clay which extends to a considerable depth, and is derived apparently from the weathering of underlying crystalline rocks. The sandstone varies in thickness; in places it is very nearly lacking. This condition gives rise to considerable variation in the subsoil. Occasionally the red clay comes quite near the surface over a small area where the sandstone is lacking. In places the sandstone or sand may be within 18 to 20 inches of the surface, and the silty layer a little thinner than typical. The silt loam in other places may be deeper than typical. In general, where the mottled silt loam to silty clay loam layer has a depth greater than 30 inches the soil is separated as the Colby silt loam, on the assumption that where the heavy subsoil is of this or a greater depth the drainage possibilities more nearly approximate those of the Colby soil. This type very much resembles the Colby silt loam, except in its sandy subsoil.

Topography and drainage.—The topography of most of the type is level. Some areas are gently undulating, but on the whole the surface is much more nearly level than in the case of the corresponding type in the Colby series. The Vesper silt loam occurs in broad, level areas which often extend for several miles unbroken except for an occasional strip of marsh lying at only a slightly lower level. Because of the flat topography, the drainage of most of the type is naturally very poor.

Where the soil section remains uniform but the surface becomes sufficiently rolling so that the surface drainage is fair to good the material has been separated on the soil map and indicated as the rolling phase.

Origin.—The material forming the Vesper silt loam has been derived from several sources. The type occurs within the region covered by the pre-Wisconsin ice sheets, and part of the mantle over the rock is doubtless of glacial origin. The extremely silty material, however, is loesslike in texture and structure and may be in part of wind-laid origin. The deep subsoil in most cases is residual from sandstone. In a few instances where sandstone is lacking the underlying crystalline rocks are the source of the material. Both surface soil and subsoil show varying degrees of acidity.

Native vegetation.—This soil was originally timbered with mixed hardwoods, white and Norway pine, and some hemlock. Practically all the pine was logged off many years ago. Large areas have been burned over, as just west of Vesper and west of Pittsville, and are now covered with a second growth of poplar. Where the land has not been burned over the present timber growth is basswood, maple, elm, birch, and poplar.

Present agricultural development.—Except in areas adjacent to the railroads this type is not highly developed. Large areas have not been cleared at all except in patches adjacent to the highways. The areas in Sigel Town probably are as well developed as any part of the type.

Surface drainage improves very much upon clearing of the land, but the level topography and tight, impervious nature of the upper subsoil cause drainage even then to be deficient. Shallow surface ditches help to remove the water, but often it is difficult to obtain an outlet low enough to empty these, and frequently water stands on the ground for several days after a rain, doing much damage to growing crops.

The principal crops grown are clover, timothy, rye, oats, and some barley. Corn is a rather uncertain crop because of the poor drainage and the danger from frosts in the low-lying, level areas. Corn for ensilage does fairly well. Grasses are especially well adapted to this soil. Crops such as cabbage, rutabagas, mangel-wurzels, and turnips produce heavy yields and the roots can be used to some extent to take the place of ensilage. When the price of cabbage is low this crop is often fed to cattle.

Improved farms on the Vesper silt loam range in value from

$35 to $75 an acre, the price depending upon the acreage cleared, the farm buildings, location, drainage, and other considerations.*

VESPER SILT LOAM, ROLLING PHASE

Extent and distribution.—The Vesper silt loam, rolling phase, occurs in the central part of the county, where it occupies the more rolling land in association with the typical Vesper silt loam. The phase occurs on slopes and hills. Throughout Sigel Town the phase occupies many short slopes, marking the boundary between one broad level area and another level area at a slightly higher elevation. Its most extensive development occurs northeast of Pittsville, where it covers several square miles.

Description.—The surface soil of the rolling phase of the Vesper silt loam to a depth of 7 to 9 inches is a grayish to grayish-brown silty loam to silt loam, containing a small amount of fine and very fine sand. It is underlain by a mottled brownish-yellow silt loam to silty clay loam which contains a very small percentage of fine sand. At 24 to 30 inches there is a very abrupt change to a yellowish or drab fine or medium sand or sandy loam or decomposing sandstone.

Considerable variation occurs in the subsoil, both in depth and character of the material. In some areas the mottled silty clay loam subsoil is undoubtedly deeper than typical, but in general where it extends to a depth greater than about 30 inches the soil is mapped as the Spencer silt loam. In places in some of the larger areas a gravelly sand occurs. This is probably of glacial origin. Associated with the sandstone are shaly layers which weather into a mottled gritty clay, with the result that occasional heavy layers are encountered in the subsoil. Fragments of sandstone occur frequently on the surface. Much of this rock is of a very indurated nature and has furnished little material to the surrounding silt loam soil. On slopes occasional rock outcrops occur. This phase resembles very much the rolling phase of the Colby silt loam, but differs in containing sandy material in the subsoil.

Topography and drainage.—The topography of the Vesper silt loam, rolling phase, is undulating to gently rolling. Most

*For a discussion of the chemical composition of this soil see page 33.

of the land is well drained. Only in the more rolling areas is the phase subject to erosion.

Origin.—The material forming this soil is from several sources and has practically the same origin as that giving rise to the typical soil. The phase differs chiefly in being much better drained.

Native vegetation.—The native vegetation on this soil consisted of oak, basswood, maple, elm, and pine. At present much of the land not improved is covered with poplar.

Present agricultural development.—A rather large proportion of the phase is under cultivation. The area northeast of Pittsville is very highly developed. The phase is a very good general farming soil, and is especially well adapted to grasses. Excellent yields of oats, rye, and barley are obtained. Potatoes yield quite heavily. In the vicinity of Pittsville an area of about 100 acres devoted to cabbage is partly on this soil. Heavy yields of cabbage of excellent quality are obtained. Root crops make excellent growth and to some extent take the place of corn, although the phase is about as well suited to corn as any of the other heavy types of the county.

Many of the small areas of the phase within broad tracts of the typical Vesper silt loam make excellent building sites and are used to quite an extent for this purpose.

The phase can be cultivated under a wider range of moisture conditions than the typical soil, and is a better all-around type, since it warms up earlier. is better drained, and slightly lighter in texture. It is considered a first-class general-farming soil. *

Improved farm land on this phase ranges in value from $75 to $100 an acre, the price depending upon the location, improvments, and other factors.

KENNAN SILT LOAM

Extent and distribution.—The Kennan silt loam, occurs in the northwestern part of the county, occupying the area known geologically as the Marshfield Moraine. This enters the county in sec. 6, T. 24 N., R. 2 E., and extends continuously east and northeast through the southwestern part of T. 25 N., R. 2 E., leaving the county in secs. 5 and 6, T. 25 N., R. 3 E. It occupies a ridge

* For a discussion of the chemical composition of this soil see page 33.

VIEW SHOWING TYPICAL SURFACE FEATURES OF COLBY SILT LOAM, ROLLING PHASE

rising 75 to 150 feet above the surrounding lowland to the south and southeast, which can be seen for a distance of 10 to 20 miles.

Description.—The surface soil is a smooth, yellowish-brown to brown silt loam 8 to 10 inches in depth. It is underlain by a light yellowish brown silt loam containing a small amount of very fine sand. At a depth of 15 inches this material gradually changes into a brownish-yellow silty clay loam. Very slight mottling brown iron stains sometimes occurs at a depth of about 20 inches. At 24 to 30 inches the subsoil becomes gritty and grades into a gravelly, sticky sand, which carries some cobbles. This coarse material is derived from crystalline rocks. Bowlders occur frequently on the surface. The surface soil resembles the Colby silt loam, rolling phase, but the subsoil does not show the mottling characteristic of the Colby series and the gravel content is greater.

In some of the more rolling and broken areas of the Marshfield Moraine the soil varies from typical in being gravelly. It usually consists of somewhat gravelly loam or silt loam underlain by a very gravelly layer, but in places the surface material has been eroded away, leaving a gravelly sandy loam exposed. This phase covers a total area of less than 1 square mile in sec. 26 and also in secs. 27, 28, 33, and 34, T. 25 N., R. 2 E. It gives good yields of such crops as rye and oats, but when planted to such crops as corn the land tends to wash badly.

Topography and drainage.—The surface of this type is rolling to very rolling, and the natural drainage is good. Some of the steeper slopes are subject to erosion, and upon these there is sometimes difficulty in using modern farm machinery.

Origin.—The soil has been formed very largely through the weathering of drift composed of ground-up granites. The Marshfield Moraine is the terminal moraine of one of the pre-Wisconsin ice sheets. The accumulation of drift which forms the ridge is of considerable depth, varying from about 86 feet at Marshfield to 156 feet at Bakerville and 160 feet north of Lindsey.

Native vegetation.—The timber growth on this land consisted of mixed hardwoods, white pine, and hemlock.

Present agricultural development.—This soil is more highly developed than any other in the county. A very large proportion of it is under cultivation. It is an excellent small-grain soil,

and corn does very well. There is less danger of damage from early fall frosts than on the Colby silt loam. The soil is very well suited to grasses and clover. It is all devoted to general farming and dairying, for which branches of agricuture it is very well adapted. The farm buildings and other improvements on this land are the best in the county.

Land values on the better improved areas of the Kennan silt loam, in the vicinity of Marshfield range from $100 to $150 an acre.*

MARATHON SILT LOAM

Extent and distribution.—This type is of rather limited extent, occupying a total area of 8000 acres. It is confined almost entirely to the northern part of the county in the Town of Rudolph, where it occurs as extensions of larger tracts in Marathon and Portage Counties. The areas are usually small and of irregular outline.

Description.—The surface soil of the Marathon silt loam, to a depth of 7 to 8 inches, is a brown to yellowish-brown silty loam or silt loam, carrying a small amount of very fine sand. Occasional rock fragments are common on the surface. The subsoil consists of a yellowish-brown silt loam grading into a silty clay loam of various colors—yellow, brown, and reddish brown. Yellowish brown predominates. This color variation does not occur as a mottling, but depends upon the character and degree of weathering of residual material in the subsoil. Below 2 to 3 feet the subsoil quite commonly, is more or less gritty and contains fragments of crystalline rocks.

This soil does not have as prominent a gray cast as does the Colby silt loam, and does not show the mottling characteristic of the Colby soils.

Included areas in the north-central part of the county, near the county line in township 25 north, ranges 3 and 4 east, vary slightly from the typical silt loam. The surface soil here is a grayish-brown to brown silt loam, 8 to 10 inches in depth, underlain by a yellowish-brown silty loam which grades into a silty clay loam. At 2 to 3 feet decomposed granite is encountered.

* For a discussion of the chemical composition of this soil see page 33.

Because of this more open subsoil the type has even better drainage than the Colby silt loam, rolling phase.

Topography and drainage.—The surface soil of this type ranges from gently rolling to rolling, and the natural drainage is everywhere good. A few of the steeper slopes show evidences of erosion, and this is apt to become more serious unless precautions are taken to minimize the effects.

Origin.—This soil apparently is partly residual. In the western part of Rudolph Town the presence of numerous bowlders would indicate that the residual material has been covered to a greater or less depth by glacial drift. The surface soil probably has originated from the weathering of the same silty covering from which the Colby surface soils are derived.

Native vegetation.—The original timber growth on this soil consisted of mixed hardwoods, white pine and scattered hemlocks. By far the greater part of the timber has been removed, only a few wood lots remaining.

Present agricultural development.—A large proportion of the land is under cultivation. The soil is very productive. It is especially adapted to oats, barley, rye, grasses, and clover. Corn does very well for ensilage, and in the average year it ripens. The steeper slopes are not well suited to intertilled crops, because of the possibility of erosion. The tendency to erode is lessened by the presence of rock fragments on the surface and through the soil.

CHEMICAL COMPOSITION AND FERTILITY OF HEAVY SOILS

The heavy soils of the Colby, Vesper, Kennan and Marathon series have a good supply of the mineral elements phosphorous and potassium.

Phosphorous.—The total amount of phosphorous in an acre to a depth of 8 inches varies from 1,100 to 1,400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorous has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorous content of this layer of soil is retained at from 1,500 to 2,000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply

of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

Potassium.—The element potassium exists in very much larger amounts in these soils than does the element phosphorous—in fact they contain on the average over 30,000 pounds of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to potassium, therefore, is connected with its availability. When a good supply of active organic matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorous which goes to the grain and is, therefore, more likely to be sold.

Organic matter and nitrogen.—Compared with prairie soils which have shown a lasting fertility, these soils are distinctly low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. When stock raising is practiced manure is available and is of course good as far as it goes, but on comparatively, few farms is there sufficient manure produced to maintain the organic matter in soils of this character, and other means should be used to supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in the organic or vegetable matter of the soil, there being none whatever in the earthly material derived from the rocks. Soils which are low in organic matter are, therefore, also low in nitrogen. By

all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soy beans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element. When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Acidity and liming.—Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies from one which would require 1,000 to that which would require 5,000 pounds or more lime to correct. This acidity is not in itself a direct detriment to the growth of most farm crops, but does interfere with the growth of the best legumes. Clover will do well while this soil is new even though acid, but after this land has been cropped a number of years the acidity should be corrected to secure the best results with medium red or mammoth clover. Alfalfa is very sensitive to acidity and lime in some form must be used to secure good results with this crop even on new land.

Crops.—Kennan and Marathon silt loams and the rolling phase of Colby and Vesper silt loams are adapted to a wide range of crops including corn, root crops, grasses and small grains. The typical Colby silt loam and Vesper silt loams, however, are not so well adapted to such a range of crops because their level surface and heavy subsoil give them rather inadequate drainage. They are, however, well adapted to grains and grasses. Fields on the Colby and Vesper soils having good slope and surface drainage can be made to produce good corn by careful management. The soils of this group are well adapted to dairy farming on account of their unusual fitness for the growing of hay and pasture.

CHAPTER III.

GROUP OF FINE SANDY LOAM SOILS.

MARATHON FINE SANDY LOAM

Extent and distribution.—This type of soil is confined to the northeastern half of the Town of Milladore where it is the prevailing upland soil. It covers a total area of 6,208 acres.

Description.—The surface 6 to 10 inches of this soil is a grayish-brown to yellowish-brown fine sandy loam, with sufficient content of fine material to be slightly sticky. Small, angular crystalline-rock fragments occur frequently on the surface and through the surface soil and subsoil, and there is an occasional bowlder. The subsoil is a yellowish-brown fine sandy loam, grading into a sticky sandy loam or fine sandy loam. Below 24 to 30 inches the subsoil becomes a sand and quite commonly contains many rock fragments. The subsoil varies to quite an extent, occasionally being a rather heavy fine sandy loam to loam. In sections 1 and 2, Milladore Town, there occurs below 30 inches a compact layer, derived probably from mica and chlorite schists. It contains a large percentage of fine mica flakes and has a smooth feel like soapstone. At 3 to 8 feet the rotten rock is reached.

Included with this type are some areas of fine sand which are too small to show as a separate type. In the northern tier of "forties" in section 25, Miladore Town, is a narrow strip of fine sand, known locally as the "sand ridge." Other small areas occur throughout the center and in the southwest corner of section 16, and in the northwest quarter of section 3. In these areas the soil consists of a yellowish-brown medium fine sand, 6 to 10 inches deep, underlain by a brownish-yellow fine sand which continues to considerable depths. The color grows lighter with depth. In cuts the sand is seen to reach depths of 8 or 10 feet. This fine sand variation contains very few rock fragments, and in places none are observed.

In one place the surface soil to a depth of 8 inches consists of a yellowish-brown fine sandy loam carrying a moderate amount of rounded gravel. This is underlain by a light yellowish brown fine sandy loam which becomes lighter in texture and color with depth. The rounded coarse material may be derived from a conglomerate or it may be of glacial origin, occuring, as it does, very near the boundary of the area of this soil.

Topography and drainage.—The topography is for the most part rolling and the natural drainage is very good, but a few included areas are nearly level or very gently rolling and some of these are not quite so well drained. When the land is cleared and the channels become better established most of these level areas will drain out readily.

Origin.—The greater part of this soil is derived from the weathering of siliceous granites, mica schists, chlorite schist, and other similar rocks. Evidences of glacial action in the form of bowlders occur in sections 5 and 13, and the soil material has very probably been reworked to some extent by the ice.

Native vegetation.—This land was originally heavily timbered with white and Norway pine, hemlock, and mixed hardwoods. The pine has practically all been cut many years ago, and much of the other timber has been taken out more recently. At present a number of farms contain some merchantable timber. Much of the land has been burned over and has grown up to poplar. This growth, with the numerous stumps and old tree trunks towering up, gives the undeveloped areas a desolate appearance.

*Present agricultural development.**—Much of this type is unused. Many settlers have recently come in and undertaken the work of clearing. Owing to its good drainage and medium texture this soil is warmer and earlier than the surrounding silt loams. It is well adapted to potatoes, small grains, and grasses. Corn will probably do much better on this soil than on the surrounding heavy types, since it warms up much earlier and is not subject to frosts, owing to its rolling topography.

Uncleared land of this type has a selling value of $15 to $25 an acre.

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* For chemical composition of this soil see page 41.

VESPER FINE SANDY LOAM

Extent and distribution.—This soil occupies a total area of 8896 acres. It occurs in the central and west-central parts of the county, where it is associated with the Boone fine sand and the Vesper silt loam. In general, the areas of this soil lie to the north of the Boone fine sand.

Description.—The surface soil of the Vesper fine sandy loam, extending to a depth of 6 to 10 inches, is a grayish-brown loamy fine sand to fine sandy loam. In some places the surface soil has a dark-brown color, due to the accumulation of organic matter. The subsoil is variable. Prevailingly it consists of a yellowish-brown to a grayish-yellow fine sandy loam, grading at 20 to 24 inches into a quite sticky, gritty clay loam. This heavy layer is of a bluish-drab color, and usually carries considerable sand, which gives it a very gritty feel. Quite commonly this layer is mottled with red, yellow, blue, and drab. In many places the heavy layer is lacking, the subsoil grading from a fine sandy loam into a light grayish yellow to yellow fine or medium sand and then into the sandstone. Fragments of sandstone are common on the surface and throughout the soil section.

This soil very much resembles the Whitman fine sandy loam in texture, topographic position, and drainage conditions. The surface accumulation of organic matter in this soil is much less, and the drainage on the average is probably a little better.

Topography and drainage.—The topography is level and the natural drainage is generally poor. In a few areas the natural drainage is much better than the average, and a small proportion of the phase has naturally good drainage.

Origin.—The material forming this soil has been derived largely through the weathering of Potsdam sandstone, with which there is associated varying quantities of shale. This shale on weathering gives rise to the clayey material in the subsoil. Both surface soil and subsoil are acid.

Native vegetation.—The timber growth on this soil at present is largely poplar, with some alder and willow. Some open strips are covered with marsh grass. The original timber consisted of Norway and white pine.

Present agricultural development.—Only a very small proportion of the type is farmed. Some of the better drained areas have been put under cultivation recently. Over a large part of the type artificial drainage will be necessary before the land can be farmed with much success. Even under the most favorable conditions this can be classed as only a fair soil. In its present condition most of the type has a low value, and for successful use it will require careful management.*

VESPER FINE SANDY LOAM, ROLLING PHASE

Extent and distribution.—This phase has practically the same area within the county as has the typical soil, covering as it does 8,896 acres.

It occurs in irregular areas associated with the Vesper soils throughout the south-central part of the county. The largest areas occur in secs. 2 and 11, T. 23 N., R. 4 E., west of Vesper, in sec. 2, T. 22 N., R. 4 E., in vicinity of Altdorf, and along the Yellow River near Pittsville. The only area of any considerable extent mapped outside the region in which the Vesper soils predominate is in secs. 11, 12, 13, and 14, T. 24 N., R. 5 E., adjacent to Mill Creek. In this area sandstone was observed the NW.¼ NE.¼ sec. 14, and for this reason all the fine sandy loam soil was mapped with the Vesper series, notwithstanding the fact that in some places no sandstone was in evidence.

Description.—The surface soil, to a depth of 8 to 10 inches, is a grayish-brown to yellowish-brown fine sandy loam, with a slightly darker color in the surface 1 or 2 inches in virgin areas. Fragments of sandstone occur frequently upon the surface and through the surface soil. The subsoil is a yellowish-brown, or in places slightly reddish brown, fine sandy loam, with a slightly greater content of clay at 15 to 18 inches. Below 20 to 24 inches it becomes lighter textured, grading into a yellowish, fine to medium sand from the underlying sandstone, which is generally reached within 3 feet. In many places the subsoil below the depth of 1 foot is a fine to medium sand.

Topography and drainage.—The topography is in most places gently rolling to rolling. In certain areas along the Yellow River south of Pittsville and along Hemlock Creek south of Vesper the surface is nearly level, but on account of the situation adjacent to the river the drainage conditions are much better

* For chemical composition of this soil see page 41.

than on the best areas of the typical soil and the land corresponds in agricultural value with that of more rolling topography.

Some areas mapped with this type consist of sandstone mounds of considerable height covered, for the most part, with a fine sandy loam soil. The slope is too steep for tillage, and rock outcrops are common. Such an area occurs about one-half mile northeast of Lindsey. These rocky and stony areas are shown on the map by symbols.

Origin.—The type has been derived largely from the weathering of Potsdam sandstone. In some places a few rounded pebbles and bowlders occur. The type occurs within, but near the border of, the area covered by the pre-Wisconsin ice sheets, and this location would account for the presence of such bowlders. The glaciation, however, was too feeble to have much influence upon the composition of the soil.

Native vegetation.—This land originally supported a heavy growth of Norway pine, white pine, and some hardwoods, but practically all the timber has been cut or burned off. At present most of the areas are covered with poplar.

Present agricultural development.—On the better portion of this type where the soil has a fair depth, and is not too stony a rather large percentage is under cultivation. Many of the areas are associated with the level portion of the Vesper silt loam, and Whitman silt loam, and are the only well drained portions of the land. As they furnish an elevated building site, quite often these spots of rolling Vesper fine sandy loam were the first land cleared.

The chief crops grown are potatoes, rye, oats, corn for silage and grasses. A few acres of cucumbers, and some root crops are also produced. While this soil does not yield as well as some of the heavier types it may be considered a fair soil and with careful management very good crops can be grown. Because of its sandy nature it warms up quicker in the spring than the heavier types, which is a decided advantage. *

ANTIGO FINE SANDY LOAM

This type occupies a total area of only 1,216 acres. It occurs exclusively on the lower terrace immediately adjacent to the

* For chemical composition and methods for the improvement of this soil see page 41.

Wisconsin River. The material has been deposited by flood waters. The soils in the Wisconsin bottoms are quite variable in composition and small areas of fine sand often occur within the fine sandy loam.

The surface soil of the Antigo fine sandy loam extends to a depth of 8 to 12 inches. It consists of a medium to dark brown, silty fine sandy loam to fine sandy loam. The virgin soil in the surface for 2 or 3 inches has a high content of organic matter, which gives it a rather dark color. The surface soil is underlain by 4 or 5 inches of loamy fine sand, and at 15 to 18 inches a medium sand of a yellowish-brown color is encountered. At 30 to 36 inches the subsoil becomes a coarse sand, containing a high percentage of fine gravel.

The original timber on this soil consisted of white and Norway pine, birch, and elm, with willow and alder along streams where drainage is somewhat deficient.

In other parts of this and other States where it is extensively developed this type is a fairly good general-farming soil. Because of its small extent in this county it is of little importance agriculturally.

CHEMICAL COMPOSITION AND FERTILITY OF FINE SANDY LOAMS

These soils are only a little more open in texture than the silt and clay loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than the heavier soils.

The total amount of the plant food elements, phosphorous and potassium, is nearly as large in the Marathon, Vesper and Antigo fine sandy loams as in the silt loams. However, they have rather less organic matter and this together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers be-

comes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of active organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of securing this result. The application of phosphorous and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

These soils were derived from rocks devoid of lime carbonates and therefore have a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of available phosphorous in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

These types of soils are well adapted to general farming and some special crops such as potatoes can also be grown to very good advantage.

CHAPTER IV.

GROUP OF LIGHT SANDY SOILS.

PLAINFIELD SAND

Extent and distribution.—The Plainfield sand occurs in a large, almost unbroken area in the southeastern part of the county, bordering the Wisconsin River on both sides. A few small areas are also scattered through the southern part of the county.

Description.—The surface soil of the Plainfield sand, extending to a depth of 5 to 8 inches, is a yellowish-brown to brownish-gray, loose and incoherent sand, consisting very largely of rounded quartz grains. In local areas and in virgin land the soil may have a slightly darker color in the surficial 1 or 2 inches, due to accumulations of organic matter. The organic content on the whole is very low. In general the surface soil is free from gravel, but occasionally gravel occurs in small quantities on the surface and mixed with the soil, as in an area just north of Grand Rapids.

The subsoil consists of a yellowish to yellowish-brown sand, which becomes lighter in color and texture with depth. The color at the bottom of the 3-foot section is usually pale yellow. More gravel appears in the subsoil than in the surface soil, but in most instances the soil section to a depth greater than 3 feet is very nearly gravel free.

The soil in general is quite uniform. In occasional areas the surface soil is slightly loamy. With increasing distance from the Wisconsin River on the west, as the water table approaches the surface, the Plainfield sand very gradually becomes darker colored and grades into the Whitman sand. A variation in color occurs in small areas in sec. 2, T. 21 N., R. 6 E., and adjoining sections, where the surface soil is a dark-red medium

sand underlain at a depth of about 24 inches by a yellowish-brown sand similar to the typical subsoil. The soil is very noticeably coarser in texture than the sand along Yellow River and undoubtedly less retentive of moisture.

Topography and drainage.—The type has a level to very gently undulating surface, occurring as a broad plain lying from 20 to 40 feet above the level of the river. Several streams from the east cutting through the terrace of the river have eroded the land to a considerable extent in places. Immediately adjacent to the Wisconsin River is a lower terrace the soils of which have a finer texture than the Plainfield sand on the high terrace. The slope between the two terraces having a medium textured sand has been included with the Plainfield sand. The natural drainage of the type is somewhat excessive and the soil suffers from drought.

Origin.—The Plainfield sand is of alluvial origin. The material has been derived mainly from sandstone. In places there is evidence of wind action. Practically all of the type is acid.

Native vegetation.—The original timber growth on this soil consisted of small jack pine, scrub oak, a few Norway and white pine trees, some white oak, bur oak, and scrubby hazel brush. All the timber of any value has been cut, but there is still much scrubby growth over the type.

Present agricultural development.—Although from 15 to 20 percent of this type has been placed under cultivation numerous farms were seen which appear to have been abandoned. The soil has a considerable lower value than the heavier types of the area and it requires careful management. Rye, Potatoes, and buckwheat are among the important crops grown and fair yields are secured in the most favorable years. Corn and some oats are also grown, but pototoes are the chief cash crop. In the vicinity of Nekoosa cucumbers are grown on a commercial scale, and are usually satisfactory in their yields. Timothy and clover are grown for hay and pasture but clover seldom does well unless given special fertilization. Liming the soil also greatly aids in getting a good stand of clover, and is really essential to continued success with this crop. Over much of the type the permanent water table lies at a considerable depth, and this with the loose open soil and subsoil result in a very droughty condition. In years when rainfall is not plentiful crops suffer

from the lack of moisture to a marked degree, but when there is a heavy rainfall, well distributed very fair yields are often secured. This soil can be profitably farmed, but it requires a thorough knowledge of the needs of the soil and very careful management.

Chemical composition and fertility.—Soils which are classified as sands are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain. The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or fineness of grain and cannot be affected by any treatment it is practical to give them. The water-holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparatively slow process and the amount of organic it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in Plainfield sand is low. The nitrogen supply in the surface 8 inches per acre is usually about 1200 to 1400 pounds. The Phosphorous supply usually ranges from 600 to 800 pounds while the amount of potassium will average close to 25000 pounds per surface 8 inches.

The starting point in the improvement of this soil is the development of active organic matter through the growth of legumes which are able to secure the nitrogen supply from the atmosphere. But before legumes can be grown with the greatest success the liming of the soil is necessary. The growth of a good crop of mammoth clover or soybeans through the use of lime and mineral fertilizers containing phosphorous and potassium is the best means of supplying this nitrogen and organic matter. In most cases this legume should be plowed under as a green manuring crop.

Probably the best way to get clover started is to seed with a small grain. By using a light seeding of rye, disked or harrowed in and seeded to clover in the spring, a good stand can usually be secured. The seed should be put in a little deeper than on

heavy soils, and the drill should be followed by a corrugated roller, or if this implement is not at hand, an ordinary roller, followed by a light harrow. When clover is seeded with a small grain in this way the growing grain heps to hold the soil in place and prevent blowing of the loose soil by the wind.

As the result of careful experiments on extremely sandy soils it appears that the best crop rotation for this class of land consists of rye, clover, and corn. If the fertility is extremely low, it will be advisable to plow under the entire clover crop. If the fertility is fair the first crop may be cut for hay and the second plowed under. While potatoes are quite extensively grown on extremely sandy soils this crop is not as well adapted to the sand soils as to sandy loam types. It has been shown by actual field tests that the yields of corn, for example, can be more readily increased on the sand soil than can the yield of potatoes. The potato when grown on sand soil does not respond to methods of soil improvement as readily as when grown on soils which contain somewhat more silt and clay. The sandy loams and fine sands and fine sandy loams are much better adapted to potato culture than are the sand soils. It is therefore advisable to reduce, where possible, the acreage of potatoes on sand soils.

With an increased acreage of corn it will be possible to put up enough silage so silage may be used for summer feeding. With this practice less pasture will be required, and this again will be desirable since the sand soils do not supply good grazing, and are not well adapted to any of the grasses. This system would make possible keeping more stock, and with the increased supply of manure the fertility of the land could be more readily maintained.

BOONE FINE SAND

Extent and distribution.—The total area of the Boone fine sand in Wood County is 14,528 acres. It occurs along the northern boundary of the large sand and marsh areas in the southern part of the county. It is mapped in irregular areas extending east and west across the county, largely in T. 22 N. Outside this general area there are numerous isolated sandstone outcrops where this soil has been formed through the weathering of the underlying rock, as around South Bluff in Remington Town.

Description.—The surface soil of the Boone fine sand is 4 to 8 inches deep. It consists of a gray to brownish-yellow fine sand. Quite commonly in virgin areas the soil in the surface 1 or 2 inches has a brown or dark-brown color, due to accumulations of organic matter. In the better drained areas, where there is sparser vegetation, this surface layer of darker material is often lacking. The surface soil is loose, incoherent, and very open. Fragments of sandstone occur frequently on the surface and mixed with the soil. The subsoil consists of a yellow fine sand which frequently becomes coarser with depth. Over a considerable part of the type sandstone comes within 3 feet of the surface. Sandstone fragments are common throughout the lower subsoil.

Because of variations in the sandstone from which this soil is derived, there are frequent variations in texture. In some areas the texture is a medium rather than a fine sand, but in all cases fine sand predominates. Occasional shaly layers in the sandstone have given rise to gritty clay loam or clay layers in the subsoil. The depth to sandstone is quite variable. In some places sandstone does not occur within the 3-foot level, while in some quite large areas it comes within 2 feet of the surface.

Some small, very wet, low-lying areas are included with this type where the soil resembles the Whitman series, except in the lack of organic matter and in the occurrence of sandstone in the subsoil.

Included with this type is a long, narrow area in secs. 21, 24, 25, and 27, T. 23 N.. R. 6 E., Rudolph Town, where the soil is a medium sand, resembling very much the Plainfield sand to the south. It differs from that type, however, in its topographic situation, lying 20 to 30 feet above the main body of the Plainfield soils. If more extensive, this soil would be mapped as the Boone sand.

In a few places the Boone fine sand occurs adjacent to the Plainfield fine sand and resembles it very much in color, texture, and topographic situation. In most cases the presence of sandstone fragments affords a means of differentiating between these soils, but in some instances this is lacking and because of depth of the sand it is necessary to separate the soils on the basis of the general location.

Topography and drainage.—The surface of the type varies from level to rolling. The small isolated areas are quite generally rolling. Many of the larger areas have a level to gently undulating topography, with occasionally small surface irregularities, due to wind action in forming small dunes.

Much of the type is well drained and droughty, but in some low-lying areas adjacent to marshes the elevation above the marsh is very slight and the water table lies too close to the surface for good results with ordinary crops. Wind erosion frequently takes place on this soil, especially after it is cleared and put under cultivation

Origin.—This soil is very largely derived from the weathering of Potsdam sandstone, but it has been modified in some cases by the action of running water, especially adjacent to the Plainfield soils.

Native vegetation.—The native vegetation consists of Jack pine, some Norway and white pine, scrub oak, birch, and poplar, the latter now predominating

Present agricultural development.—Only a small proportion of the type is under cultivation, rye, potatoes, and buckwheat being grown. Corn does poorly. The soil where well drained is droughty, owing to its loose, open structure. and has a low agriculture value.*

PLAINFIELD FINE SAND

Extent and distribution.—While most of the Plainfield sand occurs along the Wisconsin River, the fine sand is most extensive adjacent to the Yellow and Hemlock Creeks, the type extending in an almost unbroken area from the south county line to a point 2 miles north of Dexterville, following the course of the Yellow River. Over nearly all of Remington Town it is the predominating "island" type in the areas mapped as Sands and Peat (undifferentiated).

Description.—The surface soil of the Plainfield fine sand is a medium brown to yellowish-brown fine sand, 6 to 8 inches deep. The virgin soil quite commonly shows a dark-brown color in the surface 2 inches. due to an accumulation of organic matter. The

* For a discussion of the chemical composition and management of this soil see page 50.

soil in general is low in organic content except adjoining low, wet areas, where the color is a little darker. The subsoil is a yellowish-brown, uniform fine sand. In places it is bright yellow, but more commonly the color becomes lighter with increasing depth. A noticeable charateristic of most of the type is its small content of medium and coarse sand. The soil is much more coherent than the Plainfield sand and consequently not so droughty.

In some areas along the lower terrace adjacent to the Wisconsin River fine sand has been washed in over the coarser medium sand by flood waters. Several such areas occur in the vicinity of Nekoosa and to the south of this place. The soil here consists of a brown to dark-brown fine sand, 8 to 10 inches deep, underlain by lighter colored material of much the same texture to 18 to 24 inches. Underneath this in places is a shallow layer of loamy medium sand to sandy loam. In nearly all cases a medium sand, similar in texture to the soil on the surrounding high terrace, occurs at depths of 24 to 30 inches. As the soil of this character is largely of recent alluvial origin, deposited by flood waters at irregular intervals, it shows numerous irregularities in composition.

Topography and drainage.—The surface of most of the type is very nearly level. There are frequent gentle undulations. The land is all naturally well drained and the soil is somewhat droughty, except bordering marshy areas, where drainage is in places somewhat deficient.

Origin.—All of this type is of alluvial origin. It has been derived from material which came originally from Potsdam sandstone. Both surface soil and subsoil show varying degrees of acidity.

Native vegetation.—The timber growth consisted of Norway, jack, and white pine; bur oak, scrub oak, and poplar. Along the Wisconsin River bottoms there is some elm, birch, and willow.

Present agricultural development.—A small proportion only of the Plainfield fine sand is in improved farms. South of Babcock there is quite an area under cultivation, while to the north the proportion of this same type being cultivated is somewhat smaller, most of the development being adjacent to the road east of the Yellow River. Rye, buckwheat, potatoes and corn are the chief crops grown, as on the Plainfield sand. Clover

and timothy are grown to a limited extent for hay and pasture, but yields are usually not satisfactory, except when the most favorable conditions prevail, or when special fertilization has been given the crop.

Because of the finer texture of this type the Plainfield fine sand is a more desirable soil than the Plainfield sand. Average yields of most crops are somewhat larger and the type as a whole can be more easily improved.

PLAINFIELD SANDY LOAM

The Plainfield sandy loam is of very limited extent, and covers a total area of only 2304 acres. This type occurs almost exclusively on the lower terrace adjacent to the Wisconsin River. A few small areas are mapped elsewhere in the southern part of the county.

To a depth of 7 inches the soil of the Plainfield sandy loam is a brown, light sandy loam. This is underlain to a depth of about 28 inches by a light-brown medium sand, below which a mixture of medium and coarse sand and fine gravel occurs.

The surface is very nearly level, but natural drainage is fairly good. The original timber consisted of elm, scrub oak, birch, willow, and hazel.

This is an alluvial soil. It consists of material originally derived from sandstone.

In agricultural value this type is somewhat better than the sand and fine sand of the same series, but owing to its limited extent it is of little importance in the agriculture of the county.

CHEMICAL COMPOSITION AND FERTILITY OF BOONE AND PLAINFIELD FINE SANDS, AND PLAINFIELD SANDY LOAM.

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn, and potatoes, find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds in the surface 8 inches per acre. The total potassium of the surface 8 inches per acre is 25,000 to 30,000 pounds or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2 percent in the second 8 inches. They have a correspondingly low nitrogen content, averaging from a thousand to 1,500 pounds in the surface 8 inches and from 500 to 800 pounds in the second 8 inches.

The most important point in the management of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover but assists in preventing the leaching of phosphorus and maintaining it in form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other live stock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained it is very prob able that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soy beans or clover, occasionally, to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil productivity. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter and part or all of this should be

plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover and there is little loss in so doing, since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The liming and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils it must not be considered that this is an indication that they have less value, than heavier soils which are relatively higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these soils develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. This group of soils is adapted to the commercial growing of potatoes, and whenever possible such soils should be selected for this crop in preference to sand types. A good rotation for these soils consists of small grain, clover and potatoes. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204 and 230 of the Experiment Station.

CHAPTER V.

GROUP OF POORLY DRAINED SOILS.

PEAT

Extent and distribution.—In Wood County Peat covers a total area of 67,776 acres, including what has been mapped as the shallow phase. The type of Peat is mapped most extensively in the southern and southwestern parts of the county, where it is the predominating soil over many square miles. Through the central and northern parts of the country it occurs in numerous isolated areas of varying size, the largest being in the northeastern part of the county in Milladore Town.

Description.—The soil classed as Peat consists of brown to black vegetable material, much of which still shows traces of the original plant fiber. Only those areas are mapped as typical Peat in which organic matter has accumulated to a depth of 2 feet or more. In some areas the depth is greater than 15 feet. Dependent upon the stage of decomposition, the organic matter varies from raw and fibrous plant remains to a very fine grained material, which shows little trace of the original plant fiber. Over most of this type the organic soil is underlain by fine or medium sand. In those parts of the county where the surrounding upland soils are heavy the underlying material is silt and clay, with some sand. In the southwestern part of the county the peaty matter is underlain by decomposing sandstone which contains some shaly layers. These give rise to clayey material.

Throughout the marshy areas in the southern part of the county numerous small sand "islands," varying in size from a few square rods to 2 or 3 acres, occur in the midst of the marsh land. Where these "islands" occupy less than 25 per cent of the surface the land is mapped as Peat. Many of the marsh areas have been burned over, leaving a deposit of ashes. Where this is of recent origin it appears as a yellowish or reddish-yel-

low layer, 1 inch to 3 inches thick on the surface. In time this becomes incorporated with the underlying vegetable matter, and the soil takes on the appearance of well decomposed Peat.

Topography and drainage.—The surface of this land is nearly level. The small sand islands which occur in the type in the southern part of the county have only a slight elevation above the marsh. Because of the flat topography, the natural drainage is very poor. Much of the Peat land is included in drainage districts and open ditches have been dug to serve as outlets; but lateral ditches or tile are needed to complete the drainage system.

Frosts on marsh land.—It is well known that frosts frequently occur on marsh land where there is no frost on higher land. This is partly because the cold air which forms on the surface of all the ground at night tends to flow down and collect in low places, but it is also the result of the fact that the loose, spongy soil of peat marshes does not conduct the heat received from the sun during the day downward. In consequence of this, the lower layers of soil do not become warmed in peat marshes as they do in other earthy soils and the little heat left in the surface inch or two of soil is rapidly lost at night by radiation, so that the freezing point is frequently reached on such soil when it would not be on more earthy soils such as sandy loam or clay loam which would conduct the heat downward better during the day and so keep warm farther into the night.

This difficulty with peat marshes can be overcome to a certain extent by heavy rolling which, by compacting the soil, permits the heat to be conducted downward more readily. It will also to a certain extent become less in time, as the peat decomposes and takes on more of the character of muck. Nevertheless, it must always be expected that marsh land will be more subject to late Spring frosts and early Fall frosts than high land. It may be stated as a general guide, that the occurrence of killing frosts is as liable on marsh land at any given point as it is on upland soil having good air drainage about 150 miles farther north; in other words, the marshes of Dane County are as liable to have a frost which will kill corn as early as are the upland regions of Shawano, Marathon, or Clark Counties. The marsh land regions of Wood County are liable to have frost two weeks or more earlier than the hill tops of the same latitude

This means that corn and potatoes, while safe crops for the upland region, are not safe crops for the marsh land and should not be depended on as the chief crops.

Native vegetation.—The native vegetation on the open areas of Peat consists largely of marsh grass, sedges, and sphagnum moss. Where timbered the land supports tamarack, spruce, and cedar. Wild cranberry is abundant in some places. In the southern part of the county much of the marsh is open. An extensive spruce swamp occurs south of Elm Lake, in Cranmoor Town, and another in the northwest part of Remington Town, near the county line. The marsh in the northern part of Milladore Town is largely open. Just east of the "island" in this marsh there is an extensive area of tamarack and spruce. In some places along the borders of this marsh there is a heavy growth of black ash.

Present agricultural development.—Much of this land is utilized for crops which do not require thorough drainage. About 1,000 acres are devoted to cranberries, largely in Cranmoor Town. There are several cranberry bogs in the western part of Remington Town. In addition to the land actually in cranberries, many acres of the marsh are used as reservoirs for water needed in cranberry production. Marsh grass is cut on a considerable acreage for hay. Where wire grass predominates the crop is sold to grass-matting companies for $15 to $18 a ton. Sphagnum moss is gathered and shipped in considerable quantities to cities for the use of florists.

Large areas of Peat are being organized into drainage districts, and ditches are being installed. Adjacent to the ditches the land is well drained, but at some distance from them the drainage is seldom adequate. The strip of land which will be drained by the ditch is somewhat narrower in the case of the Peat than on the sandy marsh soils. In a few instances private enterprise has tiled some of the land and adequate drainage has been secured in this way. After thorough drainage has been provided fair yields of a number of crops can be secured where proper farming methods are followed. Small grains make a rank growth, but are apt to lodge and not fill out very well. Some special crops such as onions and cabbage do well on Peat land when properly fertilized, and celery is raised extensively in other regions on similar soil. Owing to the location and low situation

these Peat lands are subject to early frosts which may prevent the ripening of certain crops which mature in the early fall, especially corn and potatoes. One farmer on Peat who has put in numerous open ditch laterals, reported having raised as much as 50 bushels of buckwheat per acre, although several crops were lost through frost. He has also raised excellent crops of onions on a small scale. On this farm oats have also done well, and corn has given fair yields. Another farmer who has tile drained 200 acres of peat land reports excellentcrops of oats, fair barley, good potatoes and excellent hay. Where large tracts of peat are being improved tractors and other heavy machines are being used in a number of cases.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT

The chief difference between peat soils and upland soils consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorous, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorous in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds, or in two feet 1,350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorous less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorous. They contain on the average 0.3 per cent of this element, while good upland clay loam soils average two per cent, or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment re-

quires the use of fertilizers containing especially the elements phosphorous and potassium. These elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorous and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Crops and system of farming on marsh lands.—Since the growth of corn and potatoes to which these marsh lands would otherwise be well adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops, and rye, and to a less extent oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land not too raw good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

On account of the crops to which this land is adapted and its use as a pasture, marsh lands can be used for dairying or stock raising to good advantage.

Certain special crops, such as cabbage, onions, buckwheat, and rape, are well adapted to such lands when well drained and fertilized.

Peat, shallow phase.—Areas of Peat in which the depth of the accumulation is less than 24 inches are mapped as a shallow phase. The peaty material in these areas rests on a gray to white sand. Scattered throughout the phase are sand "islands" too

small to show on the map. Areas in which these constitute more than 25 per cent of the surface material are mapped with the miscellaneous type of Sands and Peat (undifferentiated). Where the covering of peaty matter is shallow the soil resembles the fine sand or sand. Where the accumulation of organic matter has a depth of approximately 6 inches or more the soil is mapped as Peat, shallow phase; where it is of less depth the soil is classed in the Dunning series.

Peat, shallow phase, occurs in irregular areas along the borders of large marshes and in narrow depressions in the Plainfield soils. The largest area is mapped in the eastern part of Cranmoor Town. With increasing distance from the Wisconsin River the water table in this area lies closer to the surface. The soil gradually passes from Plainfield sand through Dunning sand and Peat, shallow phase, into typical Peat.

The surface of the areas of Peat, shallow phase, is level, and the natural drainage is very poor. The native vegetation consists of marsh grass, sedges, sphagnum moss, willow, and alder.

Outside the cranberry district most of the areas of this phase are in drainage districts and are more or less thoroughly drained. Adjacent to the ditches some fairly good yields are obtained. Good crops of rye and buckwheat were observed on this land in the course of the soil survey. Considerable marsh hay is cut on some areas. The Peat, shallow phase, has a value probably slightly higher than the typical peat, but requires practically the same treatment.

MUCK.

In the surface 10 to 15 inches the type mapped as Muck consists of black, well-decomposed organic material with a considerable admixture of silt and clay. This is underlain by a blue or drab silty clay loam, which is usually quite gritty. At a depth of about 2 feet a sticky gray sand occurs and continues to a depth of 3 feet or more. The content of sand in the subsoil is variable. The material quite commonly is very sandy.

Muck covers a total area of 1.5 square miles. It occurs in depressions in the southern part of the area of Vesper soils. The soil resembles very much the associated Whitman silt loam, but has a much higher content of organic matter.

TYPICAL VIEW OF THE TYPE MAPPED AS SANDS AND PEAT (UNDIFFERENTIATED)

sons of the Dunning series.

The timber growth consists of alder and willow. In open areas marsh grass is the principal vegetation.

Practically none of the type is under cultivation at present. A small area is used for pasture in the south part of T. 23 N., R. 5 E.

In the improvement of this soil drainage is the first step. The Muck has about the same chemical composition as the Peat, the chief difference being that it contains somewhat more mineral matter, and smaller percentage of organic matter. Like the Peat it is deficient in the mineral plant food elements and these must be supplied before satisfactory yield can be secured over a period of years. When drained, cleared and properly cultivated somewhat higher yields may be expected than on the typical Peat soil. Suggestions for the improvement of Peat will apply to the Muck as well.

SANDS AND PEAT (UNDIFFERENTIATED)

Extent and distribution.—This mixed type occupies a total area of 28,736 acres in Wood County.

The type of Sands and Peat (undifferentiated) is mapped chiefly in the south-central part of the county, both east and west of the Yellow River. Near this river the type is made up largely of the Plainfield fine sand, Dunning fine sand, and Peat, shallow phase. In the eastern part of the area of this type the Plainfield sand, Dunning sand and Peat, shallow phase, are the chief soils included.

Description.—The soil material mapped as Sands and Peat (undifferentiated) is subject to wide variation. In general, it consists of several classes of marshland through which there are scattered innumerable low, flat "islands" of sand. The soil on the islands consists of a brown or yellowish sand or fine sand underlain by yellow, rusty-brown or nearly white sand of medium to fine texture. The content of organic matter in the surface soil is small and the material is usually loose and open in structure.

The sand islands included in this type are less than 10 acres in extent individually. Those covering 10 acres or more are mapped separately, the soil being classed with the Plainfield series. The soil on these islands includes the same material as

that in the larger areas of Plainfield soils. The marshland included in this group may consist of any one or more of several types. Where the islands are very close together the surface material of the intervening lowland is usually made up largely of sand, fine sand or fine sandy loam, cantaining sufficient organic matter to have a black color. The subsoil usually consists of a gray or nearly white sand varying in texture from coarse to very fine. It is in most places fine in texture. Wherever these black, sandy soils occur in an area 10 acres or more in extent they are mapped separately and classed with the Dunning series.

A Noticeable variation occurs in the subsoil of this mixed type. In a number of instances the underlying layer is a fine-textured, nearly white material sometimes referred to locally as clay. It appears to consist chiefly of very fine sand, with a small proportion of silt and probably only a very small percentage of clay. This material sometimes comes within reach of the 3-foot soil auger, but it usually occurs at a greater depth and is most often seen along the banks of freshly dug drainage canals, where it has been reached at a depth of about 3 to 8 feet. This bed of fine material does not appear to be continuous.

In some instances the type of Sands and Peat (undifferentiated) is underlain by sandstone rock with which shaly material is associated. Where open ditches are cut through such formations thin beds of clay or sandy clay are sometimes seen. These have come from the weathering of the shaly sandstone rock. Areas in which this material comes within 3 feet of the surface are of small extent.

Small areas of Peat are also included in this type of undifferentiated soils. This consists of vegetable matter in varying stages of decomposition, with which small quantities of fine earth have become incorporated. The depth of the peaty matter is variable. It is usually underlain by sand. Where the areas of Peat are over 10 acres in extent they are mapped separately.

The size of the sand islands and of the intervening strips of marsh and the relative proportions of a given area occupied by each are variable. On the whole, it is estimated that the marsh and the sand islands have about an equal aggregate extent. In areas where the sand islands cover less than 25 per cent of the surface the soil on the islands is undifferentiated and the area is mapped with the marsh soil. Where the islands make up

more than 75 per cent of the total area the whole tract is mapped as one of the Plainfield types.

Topography and drainage.—The surface of this land is level except for slight undulations due to the low sand islands which rise only a few feet above the marsh. The sand islands are usually fairly well drained, while the intervening areas of marsh are naturally poorly drained. A large proportion of this class of land has been incorporated in drainage districts and is now being reclaimed by large open ditches or canals.

Origin.—The greater portion of the material composing this mixed type is of alluvial origin, having come in part from granitic rocks, but probably more largely from sandstone formations. Varying amounts of organic matter have accumulated in the lower places, which accounts for the dark color.

Native vegetation.—The native vegetation on the sand islands consists chiefly of scrub oak, jack pine, poplar, and sweet fern, while that on the marshes consists of alder, willow, poplar, and marsh grass. Many of the marshy tracts have no tree or brush growth.

Present agricultural development.—Only a small proportion of this land has been placed under cultivation. Small areas are included in some of the cranberry growing districts. A few small fields in areas where drainage has been partly established are under cultivation, but the results have usually been unsatisfactory, owing in part at least to insufficient drainage. Marsh hay is cut from some of the open marshes, and wire grass for use in the manufacture of rugs and matting is cut in small quantities.

The construction of large, open ditches does not necessarily in itself provide adequate drainage for a soil of this character. The land bordering properly constructed ditches should be sufficiently drained, but at distances of about one-half mile or more, or sometimes even less, from the outlet ditch the drainage may not be sufficient, so that the use of tile drains or additional open ditches is necessary.

The distance back from the ditch which will be drained will depend upon the depth of the ditch and the character of the soil, and also upon the slope of the land.

When adequate drainage has been provided this land will require careful management before profitable crops can be grown over a period of years.

Chemical composition and fertility.—Because of the great variation in the materials making up this type a chemical analyses of any one phase would not be representative of the type as a whole. The analyses of the peaty portion will correspond closely with that of the typical peat. The black sandy soils have the same composition as the Dunning types, and the sand islands are Plainfield soils. The supply of phosphorous and potash is low in all the soils making up the type, and these elements must be supplied. The supply of nitrogen in the marsh soils is high, but in the soil of the sand islands it is low and should be increased. The plowing under of legumes and the applying of stable manure or mineral fertilizers containing phosphorous and potash will assist in building up the productiveness of the soil on the islands. The use of fertilizer containing potash and phosphorous will be necessary on the Peat soils before cultivated crops can be grown profitably over a period of years.

For a more complete discussion of the chemical composition and fertility of this soil reference is made to the description of the various soils which make up this mixed type.

GENESEE SILT LOAM

The Genesee silt loam occurs as first-bottom land along some of the larger streams. Along Mill Creek an area of this soil extends from sec. 32, T. 25 N., R. 4 E., throughout the remainder of the course of this stream within the county. The soil here is a silt loam, except in the last 2 or 3 square miles, where there are some sandy spots.

The Yellow River has developed a narrow strip of bottom land in the northwestern part of the county. Throughout most of Richfield Town and the northern part of Wood Town the bottom land where present is too narrow to show on the map. From a point near Pittsville the lower terrace continues southward along the river to the county line without a break except in sec. 10, T. 22 N., R. 3 E. The Genesee silt loam occurs as the predominating type as far south as the Green Bay & Western Railway line near Dexterville. South of the railroad three areas of this soil are mapped separately from the terrace immediately adjacent to the river in secs. 22, 27, and 34. These three areas constitute practically all of the type under culti-

vation. Just south of the track the land has been protected from inundation by means of a dike, and this type, with the adjoining Peat land, is being ditched and drained.

The surface soil of the Genesee silt loam, extending to a depth of 8 to 10 inches, is a medium to dark brown silt loam. Where the type is associated with the Colby soils it resembles tnem very much in texture, but is slightly darker in color. The subsoil of the type is variable. In general it consists of a yellowish-brown silt loam, grading into a silty clay loam. Lenses of sand are commonly encountered.

Both surface soil and subsoil are subject to considerable variation. Within the general area occupied by the Colby silt loam the material is a fairly uniform silt loam, but the type includes numerous small areas where the surface soil is black, resembling the Whitman silt loam, and often wet and marshy. Small sandy spots occur occasionally. In the areas associated with the Vesper, Boone, and Plainfield soils this uniformity is lacking. Here there is more or less sand along with the silt loam that has been carried in from the Colby soils, and small areas of fine sands and fine sandy loams are included within the predominating Genesee silt loam. If more extensive, these sandy areas would be mapped with the Genesee fine sandy loam.

The Genesee silt loam consists of alluvial material derived largely from crystalline rocks.

The timber growth on this soil is quite heavy. Maple, elm, birch, and ash grow adjacent to the streams, and in the wettest areas alders and willow make up the growth.

This soil is well adapted for use as pasture land when drained and protected from flooding. Hay, grain, and corn do very well. On account of the drainage requirements most of the type is of low value at present.

GENESEE FINE SANDY LOAM

The Genesee fine sandy loam occupies a total of 7,040 acres and is found as first bottom land along the larger streams within the area. The soil mapped as the Genesee fine sandy loam is quite variable, owing to its alluvial origin and liability to overflows. The type includes sandy, first-bottom soils along the Wisconsin River and the lower courses of the Yellow River, Hemlock Creek and the East Fork of the Black River.

Along the Wisconsin River the surface soil varies from a fine or medium sand to a fine or medium sandy loam. The color is yellowish brown to light brown, except in depressions, where the accumulation of organic matter has given rise to a darker color. The subsoil quite generally is a medium to coarse sand. Along Yellow River the soil is a brown fine sandy loam, with occasional small areas of silt loam.

This soil is timbered quite heavily with elm, birch, ash, and some pine. None of the land is under cultivation. Because of its poor drainage and small extent this type is of little importance in the agriculture of the county.

WHITMAN SILT LOAM

Extent and distribution.—Whitman silt loam is an extensive soil in Wood County and covers a total area of 42,112 acres. It occurs in irregular tracts through the portions of the county where Colby and Vesper soils are found. Where associated with the Colby soils it usually occurs as narrow strips along streams and drainage courses. Several quite broad level areas of very wet land have been included in this type, the largest of which is in sections 22 and 23, Town of Sherry. Through the region of Vesper soils there are many broad areas of Whitman silt loam. Most of these occur in an east and west belt extending nearly across the center of the county.

Description.—The surface soil of the Whitman silt loam, extending to a depth of 8 to 12 inches, is a dark grayish brown to black silt loam, high in organic matter. The subsoil is drab in color, mottled with brown, yellow, and sometimes red. The mottling quite commonly is more of less localized, with drab predominating. The subsoil in texture is a silt loam to silty clay loam. It becomes heavier with depth. The material is compact and puttylike, and very retentive of moisture.

Where the type is associated with the Colby soils the depth of the heavy subsoil is usually greater than 36 to 40 inches, but throughout the region occupied by the Vesper soils the deep subsoil quite commonly is similar to that of the Vesper series, being derived from sandstone. Below 30 to 36 inches, and in some places at even shallower depth, white or drab sand underlies the silty clay loam, and this in turn rests on sandstone. It

is unusual for the hard sandstone to occur within reach of the 3-foot soil auger.

Included with the type are some areas where the dark surface soil is very shallow and occasionally almost lacking. Areas of this character are low lying and very poorly drained, however, and the soil is similar in many respects to the typical Whitman silt loam, although much lower in organic matter.

The Whitman silt loam resembles the Clyde silt loam of the southern part of the state in color, texture, and structure, but it is derived from crystalline material and is acid, while the Clyde soils are encountered in limestone regions and are not acid.

Topography and drainage.—The Whitman silt loam has a very nearly level topography. Natural drainage is very poor.

Origin.—This soil consists of sediments washed from crystalline-rock debris. Because of the low position and wet condition of the land there has accumulated a large amount of organic matter, to which is due the dark color of the soil.

Native vegetation.—The natural vegetation characteristic of the narrow strips along stream courses is made up largely of alder and willow, with some elm, ash, and birch along the border. Over large areas elm, ash, and birch are more abundant, and in some places poplar is commonly associated with the alder and willow. In the wettest areas there is little timber, marsh grasses predominating.

Present agricultural development.—Very little of the type is farmed. A large area southwest of Vesper in sec. 16, T. 23 N., R. 4 E., Hansen Town, is being tiled. In the northwest quarter of sec. 35, T. 24 N., R. 5, E., Sherry Town, and in adjacent "forties" a small area of Whitman silt loam is under cultivation, but the drainage is so poor that crops do not give very good yields in years of average rainfall.

The Whitman silt loam is naturally a strong, productive soil, and with thorough drainage will make excellent land for general farming purposes. It is especially well adapted to grasses for hay and pasture. With drainage, corn for ensilage would also prove a good crop. Because of the high content of organic matter in most areas of the type, grain would probably lodge badly. Those areas with a very shallow accumulation of organic matter will, upon drainage and cultivation, develop into a soil resembling the more nearly level areas of the Colby or Vesper silt loams.

Before this soil can be cropped with much success artificial drainage must be supplied. Many of the large areas, because of the level topography, will be rather difficult to drain successfully, and much care will be necessary in laying out a drainage system.

Chemical composition and fertility.—As indicated above the Whitman silt loam of Central Wisconsin is quite similar to the Clyde silt loam of Southeastern Wisconsin, differing chiefly by being acid while the Clyde soils are not acid. From the standpoint of the plant food elements which they contain these two types represent the best balanced soils in Wisconsin. Whitman silt loam as found in Wood County contains from 3 to 5 times as much nitrogen and organic matter as does the average light colored upland heavy soil in the same region. It contains from 1500 to 2000 pounds of phosphorous in the surface 8 inches per acres, and from 40,000 to 50,000 pounds of potassium.

The availability of the phosphorous and potassium will depend largely upon the rate of decomposition of the organic matter. There is usually sufficient phosphorous available for a number of years but after a time the use of a fertilizer supplying this element may be advisable. The same is frequently true with the potassium supply. Stable manure will supply these elements, but as this soil is high in nitrogen and does not need more, the stable manure can be utilized to better advantage on upland soils deficient in organic matter, and mineral fertilizers containing phosphorous and potassium used instead on the lowlands.

The Whitman silt loam is acid, and this condition would materially interfere with the successful growing of alfalfa. While the soil is new and the fertility high clovers will do well, but after the fertility has become somewhat reduced clover may not do so well, and liming will then be advisable.

In the improvement of this type the first step is to supply adequate drainage. Open ditches will not be sufficient by themselves, and should be supplemented by the use of tile drains. As the subsoil is heavy and tight, tile will have to be placed closer together than in soils which are more open in character. When well drained this will be one of the strongest, and naturally most productive soils of the county. Except for danger from frosts it would make excellent corn land. It is well adapted to grasses and at present hay is the most important

crop produced. On the parts best drained alsike clover and timothy do very well.

A simple system of surface drains may be readily installed to give temporary relief. If the fields are plowed in narrow lands leaving dead-furrows at intervals of from 2 to 4 rods running with the slope, and leading to open ditches at the side of the field fairly good surface drainage will be provided. Such a system, however should be supplemented with tile to insure drainage which will permit growing all cultivated crops suited to the region.

DUNNING FINE SANDY LOAM

Extent and distribution.—This type occupies a total area of 7,424 acres. A few small areas are found in the northeastern portion of Milladore Township, but the most extensive tracts occur from 3 to 6 miles southeast from Pittsville. Most of the areas, which are rather small and irregular are found through the center of the county between the heavy Vesper soils and the sandy belt immediately to the south.

Description.—The surface soil of the Dunning fine sandy loam, extending to a depth of 6 to 10 inches, is a dark-brown to black fine sandy loam high in organic matter. It is underlain by a drab to yellowish-drab fine sandy loam, which becomes a sticky sand or very gritty clay loam below 18 to 24 inches. Yellow, red, blue, and drab mottling is quite common.

The surface soil is not very uniform. Considerable silt and clay is mixed with the sand in places, especially along drainage courses heading in areas of silt loam soils, in which case the soil is a loam rather than a fine sandy loam. On the other hand, small areas in which the texture approaches a fine sand are also included. Where the type occurs associated with peat soils, a 2 or 3 inch layer of peat is often encountered on the surface, as in the areas northeast of Dexterville.

The subsoil of this type also is quite variable. Within areas of sandy soils it consists of a gray to drab sticky fine sand or fine sandy loam. Occasionally layers of sandy or gritty clay loam of a drab mottled color occur where the soil is associated with the Boone fine sandy loam, poorly drained phase. In places the subsoil may be a fine to medium sand below the surface foot. Where the type is associated with the Boone soils

layers of a mottled color, with red predominating, are seen where the subsoil has been derived to a considerable extent from shaly layers in the sandstone.

In some small included areas, associated with the Plainfield sand, the texture is coarser than typical. The soil here consists of a 6-inch layer of dark-brown to almost black sandy loam with 1 or 2 inches of well-decomposed peaty material over the surface. The subsoil consists of a gray sandy loam grading into a yellow medium to coarse sand.

Topography and drainage.—The surface is level, the water table lies near the surface, and the natural drainage is poor. In some places large open ditches have been dug. Only a small proportion of the type is sufficiently drained to permit the growth of general farm crops.

Native vegetation.—Most of the land supports a heavy growth of alder and willow, with marsh grass in the broader open areas. At the head of the drainage courses the native timber consisted of ash, elm,birch, some hemlock, and pine. At present there is considerable poplar.

Present agricultural development.—Practically none of this land is utilized at present, except that marsh hay is cut to a very small extent on some of the broader open areas. Most of the type occurs in an undeveloped part of the county and probably will not be utilized until more of the upland has been put under cultivation.

In its present condition the agricultural value of this soil is rather low. In many cases the ditches constructed do not drain the land thoroughly except immediately along the ditch. Little of the type has been cleared and placed under cultivation, and the yields are usually low. Under the most favorable conditions, fair yields of buckwheat, alsike clover, and timothy are obtained. A number of other farm crops, such as corn and small grains, are frequently grown, but yields are uncertain. When thorough drainage has been supplied all of the general farm crops common to the region can be grown successfully upon this soil.

DUNNING SAND

Extent and distribution.—This type is associated with the Plainfield sand, occurring in the southeastern part of the county

on both sides of the Wisconsin River. The largest continuous area is mapped in T. 22 N., R. 5 E. Here the sand gradually becomes darker as the water table approaches the surface with increasing distance from the Wisconsin River. On the eastern side of this area the surface soil is a dark-brown medium sand, only a little darker than the Plainfield sand. The two soils merge into each other with a gradual darkening in color. On the western side, where the peat marsh is approached, there is a shallow covering of peaty matter. This accumulation gradually increases in depth with distance from the river. Throughout this area of Dunning sand there are a few scattered "islands" of Plainfield sand, 2 to 5 acres in extent, which reach an elevation of 1 or 2 feet above the surrounding wet soil and afford good building sites. In T. 21 N., R. 4, E., the Dunning sand occurs associated with the Plainfield sand in the miscellaneous type mapped as Sands and Peat (undifferentiated).

Description.—The soil of the Dunning sand to a depth of 5 to 12 inches consists of a dark-brown to black medium sand. Very commonly the virgin soil has a 2 to 4 inch surface covering of dark-brown peat containing a small proportion of sand. On cultivation this becomes mixed with the underlying sand and gives rise to a sandy peat or peaty sand, the texture depending on the relative proportions of the various constituents. The surface soil generally contains a considerable quantity of organic matter. Because of the coarse nature of the sand grains the organic matter stands out as separate particles, and gives the surface soil an apparently loamy texture.

The subsoil of this type consists of a light-yellow to gray, medium to coarse sand which becomes coarser with depth. With increasing depth the color partakes more of a gray or whitish cast and the material has a leached appearance. Occasional yellow iron stains or mottlings occur in the subsoil.

Topography and drainage.—The surface of the Dunning sand in general is level to very gently undulating, and the natural drainage is poor. Some large open ditches have been constructed, and along these the drainage conditions have been greatly improved.

Origin.—A large proportion of the material forming this soil is of alluvial origin, having been deposited by running water when the Wisconsin River was at a much higher stage than at

present, probably during glacial times or during the retreat of the ice sheet, when great volumes of water were escaping from beneath the ice. The parent material was largely Potsdam sandstone, and in a few instances the soil may be residual from this rock. The dark color is due to the accumulation of decaying organic matter, the growth of which was favored by the moist conditions. The material is acid, differing in this respect from soils of the Clyde series, which are similar in many other ways.

Native vegetation.—The native vegetation consists chiefly of willow, poplar, and alder, with marsh grass and some moss. In many places the marshy land is open and coarse grass or moss constitutes most of the growth. In others there is quite a dense growth of brush.

Present agricultural development.—Only a very small proportion of this soil has been cleared and placed under cultivation. Where open ditches have been installed it is usually fairly well drained along the ditches so that cultivated crops can be grown. Back from the ditches, however, the drainage is usually deficient. Ditches now being constructed, as a rule, are deeper than those dug in previous years and will furnish drainage for a wider area on either side of the ditch than formerly. From the undrained areas some marsh grass is cut for hay, and portions of it are also utilized for pasture, especially where it is included with a farm which is made up largely of upland soils. When drained such crops as buckwheat, alsike clover, corn, rye and other general farm crops can be grown but the yields are uncertain.

DUNNING FINE SAND

Extent and distribution.—Dunning fine sand occurs along the Yellow and Hemlock Rivers in association with Plainfield sand, in much the same relationship as the Dunning sand and Plainfield sand along the Wisconsin River. Fairly large tracts occur south and southwest of Babcock and south of Dexterville.

Description.—The surface soil to a depth of 6—12 inches is a dark brown, fine sand, carrying a fairly high percentage of organic matter. It is not uncommon for the surface 2—4 inches of the virgin soil to be a peaty material, and these have been

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* For the chemical composition and methods for the improvement of this soil see page 72.

included within the type areas where this peat accumulation has a depth as great as 6 inches. On drainage this shrinks and with cultivation sand mixed with it will give a peaty fine sand which is quite characteristic of the type.

The subsoil is a pale yellow to gray fine sand, becoming a gray or whitish fine sand at 15—18 inches. Where thrown out along drainage ditches the sand takes on an almost white appearance when dry.

Some variations in this type were noted. In the portion of this soil west of the Yellow River the sand will average a little finer than the areas to the east. The subsoil is subject to local variation. Layers of very fine sand are common and an occasional layer of even finer texture was noted where the grains were of silt size. If this very fine material were of any extent undoubtedly the subsoil would have a greater water holding capacity than the typical soil. The area in Section 27, T. 22 N., R. 3 E., in part at least is a badly burned peat marsh where the peat has burned down almost to the sand.

Scattered through areas of this soil are numerous tracts of less than 10 acres, averaging 2–5 acres, which have a slightly higher elevation than the general level and where the soil is Plainfield fine sand. If these sand islands make up over 25% of the soil the area has been included with the undifferentiated type. In cultivated fields and drainage ditches the difference in color of the soils show up very markedly.

The surface has a yellowish-brown color on the islands, while the surrounding soil has a dark brown color. In the subsoil the islands have a distinct yellow color while only a short distance away on an equal level the subsoil is gray or white. On the island the soil is low in organic matter and the yellow color indicates a much better condition of oxidation than in the surrounding Dunning soil in which the gray color is due to the deoxidation of the iron compounds.

In the undifferentiated type throughout the township of Remington and adjacent townships many small areas of Dunning fine sand occurring between islands of Plainfield fine sand have been included.

Topography and drainage.—The surface of this soil is level. Where small sand islands are associated with the type the topography has a slightly undulating character. The natural drain-

age is poor. Where ditches have been constructed the drainage is usually good, but some distance back from these ditches the drainage is usually deficient. The distance from the ditch within which adequate drainage will be secured is probably less than in the case of the Dunning sand which is much coarser, and has a lower water holding capacity.

Origin.—This soil is largely of alluvial origin, resulting from the weathering of sandstone and subsequent transportation by running water. The dark color is caused by an accumulation of organic matter, formed through the decay of vegetation which makes a rank growth on these moist soils.

Native vegetation.—The native vegetation consists of willow, alder, poplar, marsh grass and a small amount of moss.

Present agricultural development.—Until quite recently only a comparatively small portion of this type has been under cultivation. As most of the areas are included within drainage districts, drainage conditions on considerable of the type has been greatly improved and several tracts have been placed under cultivation in Sections 29, 35, 36, T. 21 N., R. 3 E., south and southeast of Babcock and also south of Dexterville.

The chief crops grown are rye and buckwheat, both of which give fair yields. Timothy, alsike clover and red top can be grown. As the soil is acid, red clover will not do well without the use of lime.

On cultivation the active organic matter in this soil, also in Dunning sand, very soon is used up through cropping and oxidation, and after a few years there are left many places where the soil is a gray-brown fine sand, very low in fertility.

If this type of soil is handled properly, and mineral plant food supplied as needed, it can be farmed profitably. Without careful management results will be uncertain.

CHEMICAL COMPOSITION AND FERTILITY OF DUNNING SAND AND FINE SAND.

These soils are well supplied with nitrogen and organic matter but they are usually deficient in the mineral plant foods phosphorous and potassium. The greatest deficiency, however, is in drainage, and before cultivated crops can be grown successfully a thorough system of drains must be provided. Open

ditches as now installed are not sufficient in themselves, and must be supplemented either by open laterals, or tile drains, or both. When drainage has been provided it will be found that the most economical and profitable crop production can be secured by the use of mineral fertilizers containing phosphorous and potassium. Such crops as alsike clover and timothy, buckwheat, and corn may be expected to give best results on this kind of land under good management.

CHAPTER VI.

GENERAL AGRICULTURE OF WOOD COUNTY.

AGRICULTURE.

The earliest settlements in this territory were made in the fifties. The sandy regions were occupied first, as the tree growth here was almost entirely pine. which was the only timber handled by the early lumbermen. Hardwood at first was of little value, and where clearings were made in hardwood sections the timber was frequently burned. The first farms were small, and large areas of land remained in the cut-over stage for a considerable length of time before they were subdivided. Agricultural development has been much slower on the sandy soils than on the heavier lands in the northern two-thirds of the county. Agriculture is more highly developed in the section around Mansfield than in any other part of the county although settlements were made in some of the sandy sections considerably earlier.

Practically all the general farm crops now grown were produced in the early history of the county, but the relative importance of a number of crops has changed. Hay and oats have always been the most important crops from the standpoint of acreage.

The censuses of 1880, 1890, and 1900 indicate for those years an acreage of rye somewhat greater than that of corn, while at present the reverse is true. In 1879 the acreage of wheat was over five times as great as in 1909. Buckwheat, peas, and beans are apparently not as extensively grown as they were 10 or 15 years ago. The greatest development has taken place in dairying and in the production of crops associated with this industry. The dairy production in 1909 was approximately seven times as great as in 1899. This rapid growth still continues, as is indicated by the fact that from 1910 to 1913 the number of cheese factories and creameries increased about 25 per cent.

The agriculture of the county at present consists chiefly of general or mixed farming, with dairying as the most important branch. The chief crops grown, in order of acreage, according to the census of 1910, are hay, oats, corn, rye, potatoes, barley, buckwheat, wheat, and peas. All of these may be considered in part as cash crops, for some of the hay and corn and a considerable proportion of the small grain are sold directly from the farm. The greater part of the production, however, is used in feeding live stock and finally finds its way to market in the form of dairy products, beef or pork. A considerable quantity of grain and hay is used as feed for work stock. Potatoes and various garden vegetables are grown mainly as subsistence crops, but small quantities are placed upon the market.

Hay is grown more extensively than any other crop. The 1910 census reports 33,951 acres in all tame and wild grasses, with a production of 53,494 tons, or an average yield of over 1½ tons per acre. About 67 per cent of the hay consists of timothy and clover mixed and about 15 per cent of timothy alone. Little clover is grown alone. Minor hay crops consist of wild marsh grass, millet, small grains, and alfalfa. Tame hay is grown by far the most extensively on the Colby silt loam. On account of the acid condition of the soils alsike clover is grown to a considerable extent. Red clover does well on land where the fertility has been kept up and thrives on new land in spite of the acidity, but on run-down fields it is not so successful.

Oats in 1909 occupied 14,664 acres and gave a production of 396,762 bushels. This crop is grown to only a small extent in the southern part of the county on the sandy soils, the greater part being produced on the Colby and Vesper silt loams and the Kennan silt loam, in the central and northern parts of the county.

The acreage of corn in 1909 was less than half that of oats. Corn, however, appears to be gradually increasing in acreage, owing partly to the rapid increase in dairying and partly to the recent introduction of varieties that can be matured nearly every year.

Rye was grown on 6,297 acres in 1909, with a total production of 78,206 bushels. This crop is grown most extensively on the sandy soils and does better on such land than any of the other small grains. It is grown with success on some of the drained

marshlands in the southern part of the county. Barley in 1909 occupied only slightly more than half the acreage devoted to rye. It is grown mostly in the northern half of the county, where silt loam soils predominate. The present acreage of wheat is small, being little more than one-tenth of that in 1899. Buckwheat is quite a common crop on the reclaimed marshy lands in the southern part of the county, but its total acreage is small.

Potatoes are quite an important crop, occupying 4,610 acres in 1909. The sandy areas produce most of the crop grown for market. Potatoes are grown for home use in all parts of the county and on practically all the various types of soil.

Peas are not grown as extensively as in former years. In 1909 the production was 3,664 bushels, while in 1899 it was 15,365 bushels, and in 1889, 17,682 bushels. More peas are now canned than formerly, but the canning industry has not yet become very important.

Cabbage is an important crop, especially in the vicinity of Pittsville, where it is grown on a commercial scale. In nearly all parts of the county it is grown for home use. Tobacco is grown on a very small total area, mainly by settlers who have come from tobacco-growing regions. Such crops as beans radishes, lettuce, onions, carrots, strawberries, and bushberries are grown on most farms.

Cranberry growing has been quite extensively developed in the southern part of the county, chiefly on peat lands. Wisconsin is the third State in the United States in cranberry production, and within the State Wood County ranks first. The Wisconsin Agricultural Experiment Station for a number of years maintained a branch station near Cranmoor, where special attention was given to questions relative to cranberry growing.[1]

The following table, compiled from census reports, shows the acreage and production of the principal crops at the last four census years:

[1] For a full discussion of this industry attention is directed to Bulletins 119, 213, and 219 of the Wisconsin Experiment Station.

Acreage and production of principal crops, census years 1880 to 1910.

Crop	1880		1890		1900		1910	
	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
Hay	7,945	9,543	23,842	23,501	28,880	38,275	38,306	57,846
		Bushels		Bushels		Bushels		Bushels
Oats	2,101	54,284	6,245	203,181	11,829	331,740	14,664	396,762
Corn	1,529	43,442	1,841	57,789	4,763	105,070	6,713	154,710
Rye	1,728	17,511	3,023	37,944	5,417	72,830	6,297	78,206
Barley	79	1,507	145	3,293	1,754	42,500	3,801	91,622
Wheat	1,323	11.906	901	15,428	2,289	34,240	244	2,784
Buckwheat	61	588	414	5,439	832	8,920	523	3,329
Potatoes	....	56,756	1,560	15,366	4,169	273,625	4,610	318,446
Peas	....	3,133	....	17,682	1,010	15,365	229	8,664
Beans	....	419	....	326	158	1,110	17	426

Fruit growing receives but little attention in Wood County. Much of its area is not especially well adapted to fruit production. The level, rather poorly drained heavy soils are not suited to the growing of tree fruits. Apples are grown more extensively than any other tree fruit. They are produced mainly in the more rolling parts of the county.

The live-stock industry is an impotant branch of farming. The 1910 census reports 32,561 head of cattle in the county, of which 18,465 are dairy cows. In 1909 there were 9,343 calves sold or slaughtered, 7,148 other cattle, 9,326 hogs, and 2, 459 sheep and goats. Dairying is the most important branch of live-stock farming. The principal dairy products are cheese and butter. A small quantity of milk is retailed in the towns. Holstein blood predominates in the dairy herds. The use of purebred sires is gradually improving the stock. There are numerous herds of purebred cattle. The tendency at the present time is to send milk to cheese factories rather than to creameries. The number of cheese factories is increasing quite rapidly, while creameries are decreasing in number. In 1910 there were 17 cheese factories and 27 creameries, while in 1913 there were 32 cheese factories and 22 creameries. The dairy products reported in 1909, exclusive of those used in the home, amounted in value to 610,475. Some beef are raised within the county but the number is much smaller than that of dairy cows. Most of the calves sold are from dairy herds. Hog raising is an im-

portant source of revenue. This industry is carried on in connection with general farming and dairying.

The character of the soil and topography has an important influence upon crop production in this county. On the heavy soils of comparatively level surface, which are cold and backward in the spring, corn does not do nearly so well as on soils of the same texture having a more rolling topography. Fruit and truck crops are but little grown in the regions where heavy, nearly level soils predominate. In the southern and southeastern parts of the county, where sandy soils predominate, the topography is not so important a factor. Except on the lowest sandy areas the natural drainage is good and frequently excessive. It is generally recognized by the farmers that the heavy soils are especially well adapted to the production of hay. Drainage increases their adaption to small grains and corn. The sandy soils are considered better adapted to rye than to other small grains, and a number of the sandy types are considered better for potato culture than the heavy soils. It is recognized that the northern part of the county, where heavy soils predominate, is better adapted to general farming and dairying than the southern part, where sandy soils and marshes abound.

The methods of farming followed are about the same as those practiced throughout the general farming and dairying districts of Wisconsin and adjoining States. The silo is in common use on dairy farms, and a considerable part of the corn crop is handled as ensilage. Hay is stored in barns or stacks and used mainly as feed for stock, though large quantities are also sold. Considerable grazing is available on cut-over tracts, and cattle, sheep, and goats are used to advantage in clearing new land. A considerable area of cleared land deficient in drainage is used for pasture.

Throughout the northern half of the county, and including the greater part of the region where heavy soils predominate, most of the farms are well equipped. The farmhouses are generally well built and in good repair. Most of the barns are built upon a stone or concrete foundation, with a cement floor, and have storage room for hay and grain. Modern stable equipment is used in dairying. Silos are often built of concrete. Milking machines are in use on a number of farms. The farm

machinery in use is modern. The work horses are mostly of the heavy breeds, such as Percheron and Belgian. The cattle are mostly of mixed breeding, with Holstein blood predominating. Purebred sires are common. Throughout the sandy parts of the county and in some sections of heavy soil where drainage is most deficient the farm improvements are as a rule below the average. On the lighter soils the work horses are lighter in weight, and modern machinery is not in as common use.

On the heavy, level or nearly level soils a rather conspicuous cultural feature is the practice of plowing fields in narrow lands, so that a dead furrow left at intervals of 2 to 4 rods will act as a ditch to help carry off the surface water. This practice greatly assists in promoting surface drainage and usually insures fair drainage without the use of tile. On some of the large tracts of reclaimed lowland in the southern part of the county traction plows are used.

On the heavy soils a rotation in quite common use consists of corn, small grain for one or two years, and timothy and clover, from which hay is usually cut for two years. The field may be pastured a year before being again plowed for corn. On the sandy soils a rotation frequently followed consists of small grain, clover, and potatoes. In no part of the county has the question of crop rotations best suited to the soils been given careful consideration by the majority of farmers. Barnyard manure is the only fertilizer used to any considerable extent.

Farm labor is not so difficult to obtain as in some sections of the United States. In many cases women and children assist with the farm work. Farm hands hired for the year or by the month are usually paid from $30 to $45 a month. Married men are usually given a house, fuel, and garden. During haying and harvesting seasons the wage for special help is about $2.00 to $2.50 a day.

The average size of the farms in Wood County is 105 acres. Land holdings range in size from a few acres to several thousand acres. In the sandy and marshy region a considerable area is held in large tracts. Some cut-over land in other parts of the county is also in large holdings. In 1910 there were 2,706 farms in the county, occupying 54.8 per cent of its total area. Of the land in farms, 38 per cent is improved. The 1910 census

reports 92.9 per cent of the farms operated by owners, 6.1 per cent by tenants, and 1 per cent by managers.

In 1900 the average value of farm land in the county was $14.40 an acre, while in 1910 it was $32.36, having increased 125 per cent. Prices depend upon the extent of improvement, location, quality of soil, and other factors, and are variable in all parts of the county. In the vicinity of Marshfield, where agriculture is the most highly developed, farms frequently sell for $100 to $125 or more an acre, while in the sandy regions partly improved farms sell for $25 to $50 an acre. Cut-over hardwood land in undeveloped parts of the county ranges in selling price from $20 to $30 an acre. The unimproved sandy and marshy soils in the southern part of the county are usually held at a figure considerably lower than this.

CHAPTER VII.

CLIMATE.

The climatic conditions in Wood County are fairly uniform, but vary somewhat from place to place with difference in topography. In the southern part of the county there are extensive marshes and sand flats, while in the northern part the soils are heavier, the surface is considerably higher, and the topography is undulating to rolling. The most pronounced variations in climate are in the occurrence of frosts. The relative liability to frost is of vital importance to the cranberry industry, which is quite extensively developed in the marshy region in the southern and southwestern parts of the county.

The only Weather Bureau station in Wood County with long records is at Grand Rapids, which is situated within the extensive sand-plain area bordering the Wisconsin River. This place is a number of miles from the larger marshy tracts, and the records, particularly those in regard to frost occurrence, do not apply to the extensive low, wet areas in the vicinity of Babcock, Cranmoor, and to the west, nor to the higher, more rolling country in the northern and western parts of the county. They do, however, apply to all the level sandy areas in Wood County east of the Wisconsin River and to the extensive sand terraces reaching back several miles from the river on the west. The following table gives climatic data colected at the Grand Rapids station and at Neillsville, which is the county seat of Clark County, adjoining Wood County on the west. Neillsville is situated in a somewhat rolling country, and the records of this station are more nearly applicable to northern Wood County than are those taken at Grand Rapids.

Normal monthly, seasonal, and annual temperature and precipitation.

Month	Grand Rapids (elevation, 1,021 feet)		Neillsville (elevation 996 feet)	
	Temperature	Precipitation	Temperature	Precipitation
	° F.	Inches	° F.	Inches
December	20.4	1.51	19.5	1.63
January	12.3	1.22	12.2	1.09
February	14.8	.64	14.0	1.33
Winter	15.8	3.37	15.2	4.05
March	30.2	1.48	28.5	1.97
April	44.4	2.56	44.6	2.82
May	56.4	4.39	55.8	4.37
Spring	43.7	8.43	43.0	9.16
June	66.5	2.91	66.2	4.59
July	69.5	3.25	69.8	3.91
August	67.6	3.21	67.1	3.63
Summer	67.9	9.37	67.7	12.13
September	60.6	3.25	59.5	3.88
October	47.1	2.14	47.2	2.92
November	31.9	1.61	31.0	1.65
Fall	46.5	7.00	45.9	8.45
Year	43.5	28.17	43.0	33.79

The following table shows the mean minimum temperatures at the Weather Bureau Station at La Crosse, Wis., and at different locations at Mather, Wis., during the season of 1907. Mather is in the cranberry region about 6 miles south of the southwestern corner of Wood County and conditions there are fairly representative for the Wood County marshes.

Month	Readings from LaCrosse Weather Bureau Station	Shelter on upland, Mather, Wis.		Shelter on marsh over moss, Mather, Wis.		At 5 inches above marsh over moss in open, Mather, Wis.	
		Reading	Difference	Reading	Difference	Reading	Difference
May	44.7	40.9	—3.8	38.1	—6.6	36.2	—8.5
June	56.2	49.1	—7.1	45.4	—10.8	42.3	—13.9
July	62.2	55.6	—6.6	51.7	—10.5	49.0	—13.2
August	59.3	54.0	—5.3	50.1	—9.2	47.1	—12.2
September	50.7	47.1	—3.6	44.3	—6.4	40.4	—10.3
October	38.2	33.4	—4.8	29.9	—8.3	25.3	—12.9

These tables indicate that temperatures for the southern portion of the county, especially over the marshy regions, are somewhat lower than over the higher and more rolling sections of the area. This means that the length of the growing season between killing frosts is shorter on the lowlands and that there is also more danger from summer frosts. Because of these conditions such crops as corn and potatoes should not be regarded as crops of major importance on the reclaimed marsh lands, although corn can be grown for silage with a fair degree of certainty of its escaping summer frosts.

The winters in Wood County are long and severe, but the summers are pleasant. The rainfall is normally well distributed throughout the growing season. The months of May, June, July, and August each have on an average approximately 3 inches of rain, but in any of these months, especially July and August, there may be periods during which crops suffer considerably from drought.

The average date of the last killing frost in the spring as recorded at Grand Rapids is May 23, and that of the first in the fall September 26. This gives an average growing season for the vicinity of the station of approximately 126 days. In the marshy region to the west and southwest the period free from frost is shorter, and summer frosts are not uncommon in the cranberry-growing districts.[1]

[1] For a full discussion of climatic conditions and their relation to the cranberry industry in Wisconsin see Bulletin T of the U. S. Weather Bureau and Bulletin 223 of the Wisconsin Experiment Station.

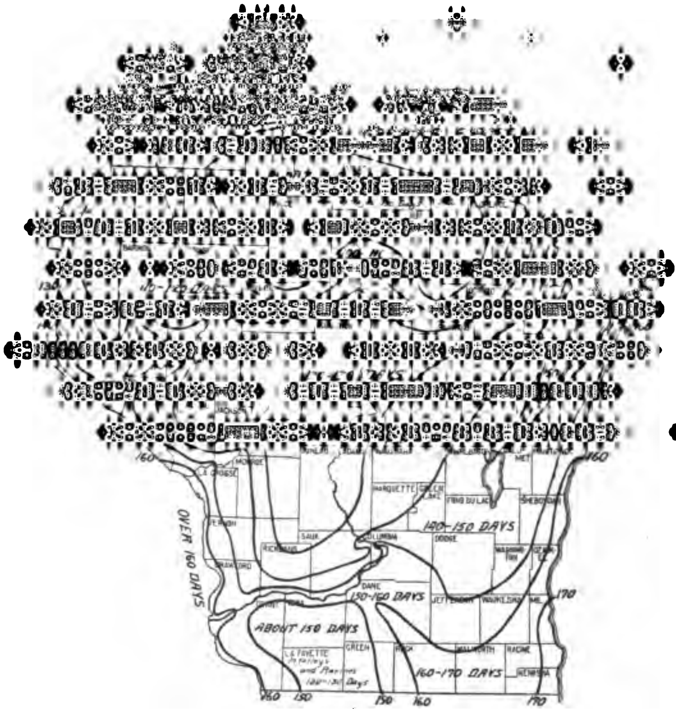

Fig. 2.—Map showing length of growing season for corn.

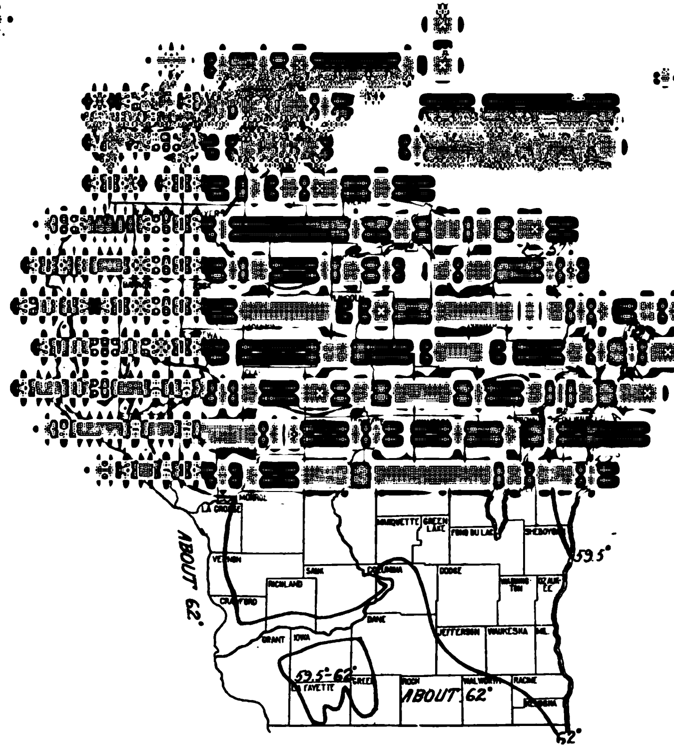

Fig. 3.—Map showing average temperature for the six growing months April to September, inclusive. Note that the difference between the average temperature for the area surveyed, and the southern portion of the State is only slight.

SUMMARY

Wood County is situated in the central part of Wisconsin and comprises a total area of 809 square miles or 517,760 acres. It includes two physiographic divisions, separated by a line extending east and west a short distance north of the Green Bay & western Railroad. North of this line the surface is nearly level to rolling. The soils are heavy and for the most part of high agricultural value. Many localities are well improved. There are but few marshes and no lakes in this region. South of this line the country is level. The soil here is quite sandy, marshes are numerous, and the land in general has an agricultural value considerably lower than in the northern part of the county.

The Wisconsin River receives the drainage of practically all the county. An area equal to about two townships in the west-central part drains through the East Fork of the Black River into the Mississippi River.

Wood County in 1910 had a population of 30,583. Grand Rapids, the county seat, and Marshfield are the two largest cities, with populations in 1910 of about 6,500 and 5,800 respectively. The county has excellent railroad facilities, and many large cities are within easy reach.

The soil material of Wood County has been derived from glacial, residual, alluvial, and, possibly in part, from loessial material. The soils have been classified into 10 series and 18 types, exclusive of Peat and Muck, each of which has characteristics by which it can be recognized.

The best land occurs in the northern half of the county, where Colby, Kennan and Vesper silt loams are the predominating types of soil. The most improved farming section is in the vicinity of Marshfield. Agriculture is least developed in the southern part of the county. Sandy and marshy soils predominate there. Large drainage projects under way are reclaiming extensive areas of marsh land.

The chief crops grown in Wood County are hay, oats, corn, rye, barley, and buckwheat. Cranberries are produced quite extensively in the southern part of the county, chiefly on Peat

lands. Wood County is first in the State in the production of cranberries. General farming is the leading type of agriculture in Wood County, and dairying is the most important branch. The dairy output is chiefly in the form of cheese and butter. The number of cheese factories is increasing quite rapidly, while the number of creameries is slowly decreasing. The northern two-thirds of the county is especially well adapted to the production of hay and grasses, and dairying is most highly developed throughout this region.

Of the total area of the county, about 54.8 per cent, according to the 1910 census, consists of farm land, of which 38 per cent is improved. The average size of farms is 105 acres. About 93 per cent of the farms are operated by owners, 6 per cent by tenants, and 1 per cent by managers. The average value of all farm land in 1910 is reported as $32.36 an acre, showing an increase in the preceding 10 years of approximately 125 per cent. The most highly improved farms in the northern part of the county have a selling value of $100 to $125 or more an acre, while hardwood cut-over lands sell for $20 to $30 an acre. Partly improved lands in the southern part of the county have a selling value of $25 to $50 an acre. Unimproved lands in the sand and marsh country have a selling value considerably lower than unimproved hardwood land.

The mean temperature for the year, as recorded at Grand Rapids, is 43.5°. The mean for the winter is 15.9°, for the spring 43.3°, for the summer 67.9°, and for the fall 46.9°. The months from April to September, inclusive, have an average rainfall of over 2.5 inches each, and May and June each have over 3 inches on the average. The average length of the growing season is 126 days.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

E. A. BIRGE, Director. **W. O. HOTCHKISS, State Geologist.**
A. R. WHITSON, In Charge, Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean.

BULLETIN NO. 52--C **SOIL SERIES NO. 18**

SOIL SURVEY

OF

PORTAGE COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, T. J. DUNNEWALD, AND LEWIS P. HANSON

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

L. R. SCHOENMANN

OF THE

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS,
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

MADISON, WISCONSIN
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* Scientist in Soil Survey. In charge of field operations in Wisconsin for the Bureau Soils, U. S. Department of Agriculture.

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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by lo-

cating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and course sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, Coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay.—Less than 20% silt.

Soils Containing over 50% of Silt and Clay.

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.— Over 30% clay.

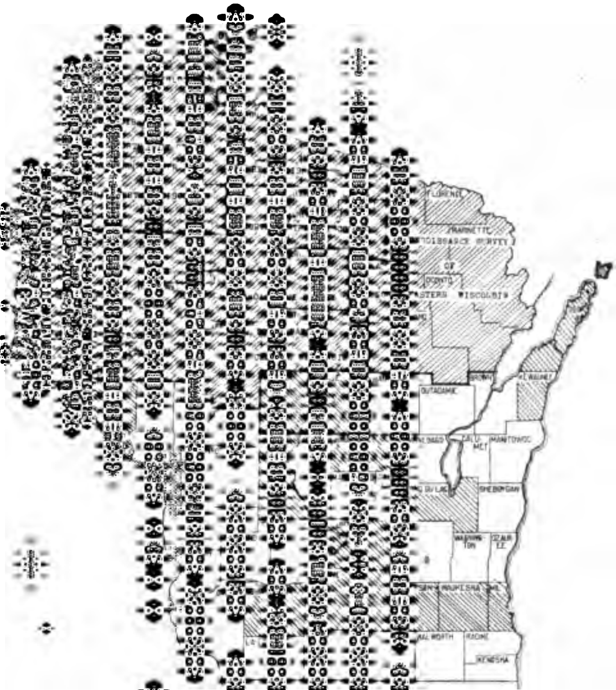
Soils may be grouped in another way. Where soils are closely related through similar sources of the material from

which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for examples, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color; topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

...GE COUNTY,

...D HISTORY

... in the geographical ... regular in its outline ... each way but for the



... ea surveyed.

... part of Wood County. ... pproximately 519,680

Surface features.—The surface features of Portage county fall naturally into three divisions. Extending south from near the center of the north line of the county to the southern and southwestern boundaries is an extensive belt of level land. On the south this has a width of about 18 miles and extends north along the western border to the Wisconsin River. As it extends north it becomes narrower and on the northern boundary line is about 12 miles wide. This extensive plain-like tract is largely a water laid deposit consisting of stream terraces and outwash plains. Some very extensive marsh tracts occur within this belt. To the west from this level stretch, in the northwestern corner of the county is an area of residual country where the surface is undulating and the topography more mature than elsewhere in the county. The slopes are usually long and gentle. East of the level area, and covering about one-third of the county is a region where the surface is characteristic of a glacial region. Immediately bordering the level plain on the east is the terminal moraine of the late Wisconsin ice sheet forming a drainage divide, and back of this are drumlins, recessional moraines, high terraces, eskers, potholes, etc. making up a surface which ranges from level to rolling and hilly. This is the roughest and most irregular part of the survey. Some slopes are too steep to be cultivated.

Throughout the area of the moraine are to be found numerous small lakes where water has accumulated in the depressions of the uneven surface. Some of these lakes have no surface outlet, while others have. Still other depressions which were originally lakes are now marshy or swampy areas. In some of the depressions the accumulated organic matter has so far decayed as to form a soil of the nature of peat or muck. The forest growth is mainly tamarack, with some cedar. These swampy areas among the hills are all comparatively small. In the southwestern part of the county is a marshy area covering about 55,000 acres, a large part of which has been drained. Another large marsh occurs along Little Eau Plaine River in the northwestern part of the county, and some of this has also been reclaimed, but most of this marsh is in adjoining counties.

Throughout the plain-like region, differences in elevation are only slight. Stevens Point has an elevation of 1,086 feet, Bancroft 1,089 and Junction City an elevation of 1,142 feet above sea level. The average for the county is about 1,100 feet.

Water power.—The Wisconsin River is the largest stream in the county. Here water power is being extensively developed, and much more is available for development. The smaller streams also present some possibilities for water power development but on a much smaller scale.

Settlement.—In 1820 the area of the county, together with the whole of upper Wisconsin, was an unbroken wilderness. It, like several of the surrounding counties, was first visited by the white man for its pine timber. The Indians became alarmed at the rapid increase of lumbermen, and complained to the Government agents. In 1836 a treaty was made with the Menominee Indians for the cession of a strip of land 3 miles in width on each side of the Wisconsin River, from Point Bas, 40 miles up the river, to permit the operations of the lumbermen. This was offered for public sale in 1840, which opened the country, to the extent of this strip, to occupation and settlement. Early records show that the first settlers came principally from Illinois, Ohio, Pennsylvania, New York, and Maine, and a few from Canada. At present quite a large proportion of the population of Portage County is made up of Poles, Germans, Norwegians, and Swedes, who moved here mostly between the years 1850 and 1870. Many of them emigrated directly from Europe, while others came from the Eastern and Central States. In 1910 the population of Portage County was 22,253. Of this 71.9% was rural. There is an average of 27.4 people per square mile over the whole county.

Stevens Point is the county seat and largest town in the area. In 1910 it had a population of 8,692. This is the only place within the survey having a population of over 1,000. Among other towns and villages are Junction City, Plover, Arnott, Amherst, Bancroft, Rosholt, Almond and Amherst Junction.

Transportation facilities.—Four railway systems have lines extending into this area and fairly good transportation facilities are afforded all parts of the survey. The Soo Line (old Wisconsin Central) crosses the county from southeast to northwest, passing through Amherst, Stevens Point and Junction City. A branch of this road runs south from Stevens Point to Portage. The Green Bay & Western crosses the area from east to west through Amherst Jc., Plover and other points. It has a spur into Stevens Point from Plover. The C., M. & St. P. Ry.

traverses the extreme western side of the county, passing through Junction city. A branch of the C. & N. W. extends into the northeastern corner of the survey, reaching Rosholt.

Public roads.—Throughout the plain-like part of the area the wagon roads are naturally sandy, which is also true of some of the roads in the southeastern portion of the county. Throughout the remainder of the survey the soils are heavier and roads naturally better. In practically all communities good roads are being constructed, and there are now many miles of excellent highways. Rural free delivery routes reach all parts of the county and the telephone is in common use throughout the country districts.

Markets.—The towns within the area provide markets for considerable farm produce, but most of the surplus from the farms is shipped out. Livestock goes mostly to Chicago and Milwaukee as does also the potato crop. Dairy products find a market throughout the middle west.

SOILS

The region covered by the present survey, in common with a considerable area extending over several counties in central Wisconsin, owes the general character of its surface to several different processes of formation. The materials may be of glacial, residual, alluvial and possibly loessial origin. To these may be added the accumulation and decay of large amounts of vegetable matter in low places and the formation of Peat.

From a geological standpoint the county falls naturally into two divisions, and a straight line drawn across the area and passing through Plover and Custer will closely mark the line of contact between the two formations represented here. To the north of this line the surface rock consists of crystalline rocks made up chiefly of granite and gneiss. To the south of the line the bed rock consists largely of Potsdam sandstone.

The soils of glacial origin occur to the east of the terminal moraine which extends across the entire county from north to south in about the center of Townships Range 9 East. This moraine marks the border of the Late Wisconsin Glaciation. The topography of this region is of a rather irregular character which is typical of most glacial soils.

The portion of the county west of the terminal moraine is

within what is commonly called the driftless area or the area over which the glaciers did not extend. The soils of this portion are of two distinct sources of origin. Occupying the greater part of the southwestern part of the county, and extending north along the Plover and Wisconsin Rivers, is an extensive area of level, sandy land which is largely of water laid origin. In the lowest places the accumulation of decaying vegetable matter has given rise to extensive areas of peat. The second class of soil is found in the extreme northwestern quarter of the county. Here the soils are largely of residual origin, having been formed from the weathering of the underlying crystalline rocks.

All rock formations have contributed to a greater or less extent in the formation of the soils of the county. In sections where sandstone is the underlying rock, the soils are found to be derived in part from crystalline rocks and in part from sandstone rocks. This has been brought about by glacial action, through the movement of the ice sheet from a region of crystalline rocks to the north and east, and moving to the southeast carrying with it crystalline material. Since first deposited, the various soil materials have been modified by various agencies such as running water, frost, wind, and the accumulation and decay of vegetable matter. This material has been classified into 14 soil series and 24 soil types, each of which has characteristics by which it can be readily recognized.

The Marathon series consists of light colored upland soils in the unglaciated section where the soil has been formed chiefly from the weathering of underlying crystalline rocks. It is confined to the northwestern portion of the county west of the Plover River and north and west of the Wisconsin River. Two types, the silt loam and fine sandy loam, were mapped.

The Colby series includes light colored upland soils within the region covered by an early glaciation and also in the driftless area. Its chief characteristics are quite level topography, a mottled and heavy subsoil and poor drainage conditions. The silt loam and fine sandy loam were mapped in this county and they are closely associated with the Marathon soils. The Colby series differs from the Marathon chiefly in being lower, more nearly level, and having a strongly mottled subsoil. It may be of the same or slightly different origin.

The Kennan series comprises the light colored, upland timber soils within the glaciated region where the material has been derived largely from crystalline rocks. This is one of the most Important series in the county and included much of the best farming land in the area. It is mostly confined to the eastern half of the county to the east of the terminal moraine. Two types, the loam and fine sandy loam were mapped.

The Antigo series comprises light colored, timbered, alluvial soils which occur as stream terraces, filled in valleys or outwash plains above the present flood plain where the parent material has been derived largely from crystalline rocks. This series is found chiefly associated with the Kennan series throughout the eastern half of the county. Antigo loam and fine sandy loam were mapped.

The Plainfield series comprises light colored, timbered, alluvial soils where the parent material was largely sandstone, but with which some crystalline material has frequently been mixed. The soils of this series are mostly light textured. They are confined to the Wisconsin River valley in the southwestern part of the county. Two types, the sand and sandy loam, were mapped.

The Waukesha series comprises dark colored, alluvial soils which were sparsely timbered, and where the material occurs as stream terraces, filled in valleys or outwash plains. It is quite similar to the Antigo and Plainfield soils, and the parent material has doubtless come both from sandstone and crystalline rocks. Three types, the sand, sandy loam and fine sandy loam were mapped.

The Dunning series comprises low-lying, dark colored soils underlain by light colored material. The soil is poorly drained and the parent material was largely sandstone. The material is always acid. The sand and sandy loam of this series were mapped.

The Whitman series comprises low-lying, dark colored soils derived chiefly from crystalline rock material. The material may be alluvial or it may occupy poorly drained depressions in the upland. Soils of this series are always acid. The heavy types usually predominate. Whitman silt loam is the only type of this series mapped in Portage County.

The Boone series comprises light colored, upland soils which have been derived chiefly from the weathering of Potsdam sand-

stone. The Boone soils are very limited extent in this survey and are confined to the west central portion of the county. Boone sandy loam is the only type of this series mapped.

The Coloma series consists of light colored upland timbered soils derived largely by glaciation from sandstone formations. Some granitic material has also been mixed with the sandstone drift through glacial action. Sandy types predominate in this series. Two types, the sand and sandy loam were mapped in this area.

The Vesper series includes light colored upland soils where the surface is usually level, or nearly so, and where the subsoil consists of sandstone rock or sandy material derived from sandstone. Natural drainage is poor except on the rolling phase, and the soil is acid. The silt loam is the only twpe mapped.

The Genesee series comprises light colored, first bottom lands which are subject to annual flooding. The series is of limited extent and of minor importance in this county. The fine sandy loam and silt loam were mapped.

Peat consists of accumulations of vegetable matter in varying stages of decomposition, with which there has been incorporated a small amount of mineral matter. The typical Peat and a shallow phase were mapped.

The following table shows the actual and relative extent of each of the soils mapped in Portage County.

AREA OF DIFFERENT SOILS

Soil	Acres	Per cent
Peat	66,560	16.4
Shallow phase	18,624	
Plainfield sand	78,592	15.1
Coloma sand	68,480	14.2
Shallow phase	5,440	
Colora sandy loam	51,840	10.9
Shallow phase	4,928	
Plainfield sandy loam	33,536	6.4
Dunning sand	23,232	4.5
Kennan fine sandy loam	22,976	4.4
Colby fine sandy loam	22,720	4.4
Waukesha sand	21,824	4.2
Dunning sandy loam	15,232	2.9
Kennan loam	13,632	2.6
Marathon fine sandy loam	13,440	2.6
Colby silt loam	12,800	2.6
Rolling phase	640	
Antigo fine sandy loam	10,238	2.0
Waukesha sandy loam	5,440	1.0
Antigo loam	5,312	1.0
Whitman silt loam	5,248	1.0
Genesee fine sandy loam	5,248	1.0
Genesee silt loam	4,544	.9
Marathon silt loam	3,008	.6
Vesper silt loam	832	.5
Rolling phase (Knox silt loam)	1,536	
Boone sandy loam	1,920	.4
	519,680	

CHAPTER II

GROUP OF HEAVY SOILS

COLBY SILT LOAM

(Including the rolling phase)

Extent and distribution.—The Colby silt loam occupies a total area of about 21 square miles and is confined chiefly to the northwestern part of the county largely in Township 24 N., R. 6 E. It joins very extensive areas of similar soil in Wood County.

Description.—The surface soil of this type to an average depth of 8 inches consists of a light grayish brown silt loam, which has a very high content of silt and a smooth feel. The subsoil consists of a heavy, compact, drab or bluish silt loam strongly mottled with yellow, brown, and red. This grades into mottled silty clay loam at about 2 feet, and the heavy material usually extends to a depth of over 3 feet. In some places there is found in the subsoil a layer of red, sticky sandy clay loam in which angular rock fragments are found.

Some variations occur in this soil. A portion of the type differs from typical Colby silt loam in being within the unglaciated region so that the subsoil at least is largely of a residual origin. The area in sections 19 and 20 (T. 24—R. 7 E.) has a subsoil of sticky reddish clay. This red clay is found at depths varying from 8 to 36 inches beneath the surface; however, in certain localities it appears on the surface. The subsoil of all the Colby silt loam in Portage County is more variable than that found in the large areas of the same type of soil in Wood and Clark Counties. It ranges from a sticky fine sandy loam to heavy clay loam, however, all of it is very tight and impervious.

Topography and drainage.—The surface of the Colby silt loam varies from level to gently rolling. Where it is level or

only very gently rolling it has been mapped as typical soil, but where there is sufficient slope to insure fair to good surface drainage, a separation has been made on the soil map and the better drained portion referred to as the rolling phase of the Colby silt loam. The rolling phase is of very limited extent. The only difference between the two phases is that of topography. The drainage conditions on the typical soil are poor and the land is apt to be cold and wet in the spring and after heavy rains.

Origin.—This type of soil has probably been formed from two sources. The surface soil came in part from the weathering of a thin glacial deposit of the early Wisconsin Ice Sheet; while the deep subsoil, and in places some of the surface, is residual, having been derived from the underlying crystalline rocks. As there is no limestone in this section, a very strong acidity prevails.

Native vegetation.—The original stand of timber consisted of maple, birch, elm, basswood, hemlock, pine, and balsam.

Agricultural development.—Most of the Colby silt loam is cleared and under cultivation. It is a strong, productive soil and when properly managed produces very good yields of all the common farm crops.

The type is well adapted to general farming and dairying and most of it is well improved. The typical soil in its undeveloped stage is inclined to be rather wet but when cleared and cultivated the drainage conditions improve somewhat. However, tile drains are needed in order that the soil may be permitted to drain out and warm up earlier in the spring.

The chief crops grown are clover and timothy for hay, oats, barley, corn and potatoes. On the best drained areas very good yields are usually secured. The type is especially well adapted to grasses, and portions too wet to be tilled in the spring provide excellent pasture.

This soil is more difficult to handle than any of the other types of the county and care must be exercised to plow when moisture conditions are most favorable. With care a mellow seed bed can be secured with but little difficulty. Fall plowing is practiced on many farms and this is advisable.*

* For chemical composition and management of this soil see page 23.

MARATHON SILT LOAM

Extent and distribution.—The Marathon silt loam is not an extensive soil in this county. It is confined to the northwestern corner, chiefly Carson Township, with a few small patches in Eau Plaine Township. The total area is about 3,000 acres.

Description.—The surface soil of this type to an average depth of 10–12 inches consists of a brown or dark yellowish-brown silt loam. Granitic rock fragments of irregular shape and small size are scattered quite thickly on the surface in places and some fragments also occur through the soil section. The subsoil is of a lighter yellowish-brown color than the surface and in texture is a compact silt loam which at from 20–30 inches becomes a reddish or yellowish heavy silty clay, or sandy clay loam containing small residual granitic fragments of various colors. A layer of fine sandy loam or sandy loam may occur in the heavy residual subsoil in some places. The underlying formation which is entirely crystalline rock is usually found at a depth of from 3 to 6 feet. In some places the subsoil consists simply of disintegrated rock which is often quite highly colored.

Topography and drainage.—In topography this type of soil varies from undulating to gently rolling. The surface is always sufficiently rolling to insure excellent surface drainage.

Origin.—The surface soil of this type is probably largely residual but in places it has a loess-like appearance and may have been deposited in part by wind action. The subsoil is principally residual, having been formed by the weathering of the underlying rocks which are chiefly very coarse grained granites. While a few glacial boulders are found scattered on the surface, the effect of glaciation over this region was too slight to influence to any extent the formation of the soil.

Native vegetation.—The original stand of timber was chiefly hardwood mixed with hemlock, balsam and pine. The hardwoods predominated in nearly all cases, but in a few areas the pine made up the greater proportion of the tree growth. Most of the timber has been removed, and in places a second growth of poplar has sprung up.

Agricultural development.—Because of its limited extent, this type is of but small agricultural importance, but the greater part is under cultivation and highly improved.

This soil is devoted to general farming with dairying as an important branch. It is a strong productive type and well suited to all general farm crops. Yields run about as follows:—corn about 50 bushels per acre, oats 30 to 50 bushels, barley 30 to 35 bushels, potatoes 150 to 200 bushels, and hay 1½ to 2 tons per acre.

Fall plowing is common for this soil. It is more difficult to cultivate than soils of lighter texture. The presence of rock fragments also makes cultivation more difficult than where these are not found. This soil is acid and but little if any effort is being made to correct this condition.*

VESPER SILT LOAM

This soil is of very limited extent, occupying a total area of less than 2 square miles. It is found chiefly to the southwest of Stevens Point in the Town of Linwood.

The surface soil of the Vesper silt loam, extending to an average depth of 12 inches, is a light-brown to brown silt loam, underlain by buff or mottled drab or yellow silt loam. At a depth of 18 to 22 inches a layer of reddish-brown or mottled, compact silty to sandy clay loam, 2 to 6 inches thick, is encountered. Below this the subsoil consists of either a mottled drab and yellow sandy loam or a yellowish sticky sand. Sandstone occurs in this lower subsoil at or near the depth of 3 feet and fragments and slabs of this rock are common on the surface and through the surface soil, but not in sufficient abundance to render the soil stony.

The topography is level to slightly sloping. Both surface drainage and underdrainage are slow and imperfect. The original timber growth included oak, elm, maple, basswood and white pine.

The type is largely under cultivation. The principal crops are hay and oats. Part of the type is used for pasture and a smaller acreage for growing corn. Potatoes are grown to a small extent, but the soil is rather heavy and wet for this crop. Hay yields 1 to 1½ tons per acre and oats about 35 to 45 bushels.

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* For discussion on chemical composition and management of this soil see page 23.

This soil occurs in a region devoted largely to general farming and it is utilized chiefly for this purpose. It is more difficult to handle than soils which have a somewhat rolling surface and better drainage. No commercial fertilizers are used, and little stable manure is available.

VESPER SILT LOAM, ROLLING PHASE*

(Knox Silt Loam)

This soil is confined to a few small areas southwest of Stevens Point, chiefly in Linwood Town. It occurs associated with Vesper silt loam. It has a total area of about 1,500 acres.

The soil to a depth of 8 or 10 inches is a light-brown, or when dry a grayish-brown, silt loam. This is underlain by a buff-colored silt loam. The subsoil is very similar to that of the Vesper silt loam except that the mottling is less pronounced and often entirely lacking. In the western part of secs. 18 and 19, T. 23 N., R. 7 E., a small area of fine sandy loam is included with the silt loam. Except for these variations the type is quite uniform.

The surface has a gently rolling to rolling topography, and both surface drainage and underdrainage are good. The original timber growth consisted of oak, maple, and white pine. The soil is considered productive and especially adapted to small grains and hay and pasture grasses. A fairly large proportion of the type has been cleared and put under cultivation. The principal crops are oats and hay, with a smaller acreage of corn and potatoes. Oats ordinarily yield from 35 to 50 bushels per acre, hay 1½ to 2 tons, potatoes 150 bushels or more, and corn 30 to 40 bushels.

This soil is not difficult to handle, and a good seed bed can be worked up with little difficulty, No commercial fertilizers are used and green manuring is seldom practiced. The supply of stable manure is inadequate. Little attention is given to selecting crop rotations best suited to the soil.

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* On the accompanying soil map this phase is shown as Knox silt loam.

CHEMICAL COMPOSITION AND FERTILITY OF HEAVY SOILS

The heavy soils of the Colby, Vesper and Marathon series have a good supply of the mineral elements phosphorous and potassium.

Phosphorus.—The total amount of phosphorus in an acre to a depth of 8 inches varies from 1,100 to 1,400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorus has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorus content of this layer of soil is retained at from 1,500 to 2,000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

Potassium.—The element potassium exists in very much larger amounts in these soils than does the element phosphorus—in fact they contain on the average over 30,000 pounds of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to patassium, therefore, is connected with its availability. When a good supply of active organic matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorus which goes to the grain and is, therefore, more likely to be sold.

Organic matter and nitrogen.—Compared with prairie soils which have shown a lasting fertility, these soils are distinctly low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. When stock raising is practiced manure is available and is of course good as

far as it goes, but on comparatively, few farms is there sufficient manure produced to maintain the organic matter in soils of this character, and other means should be used to supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in the organic or vegetable matter of the soil, there being none whatever in the earthy material derived from the rocks. Soils which are low in organic matter are, therefore, also low in nitrogen. By all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soy beans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element. When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Acidity and liming. Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies from one which would require 1,000 to that which would require 5,000 pounds or more lime to correct. This acidity is not in itself a direct detriment to the growth of most farm crops, but does interfere with the growth of the best legumes. Clover will do well while this soil is new even though acid, but after this land has been cropped a number of years the acidity should be corrected to secure the best results with medium red or mammoth clover. Alfalfa is very sensitive to acidity and lime in some form must be used to secure good results with this crop even on new land.

Crops.—Marathon silt loam and the rolling phase of Colby and Vesper silt loams are adapted to a wide range of crops in-

cluding corn, root crops, grasses and small grains. The typical Colby silt loam and Vesper silt loams, however, are not so well adapted to such a range of crops because their level surface and heavy subsoil give them rather inadequate drainage. They are, however, well adapted to grains and grasses. Fields on the Colby and Vesper soils having good slope and surface drainage can be made to produce good corn by careful management. The soils o fthis group are well adapted to dairy farming on account of their unusual fitness for the growing of hay and pasture.

CHAPTER III

GROUP OF MEDIUM HEAVY SOILS

KENNAN LOAM

Extent and distribution.—The Kennan loam is confined almost entirely to the eastern tier of townships where it is associated with other soils of the Kennan, Antigo, and Coloma series. It has a total area of about 21 square miles, and is one of the best soils in the county.

Description.—The surface soil to a depth of 14 to 18 inches is a light brown or buff colored loam to silt loam underlain by a brown compact gravelly sandy loam or sandy clay which changes gradually at 24 to 30 inches or below into a brown or yellowish sand and gravel.

Over virgin areas the surface few inches are dark due to an accumulation of organic matter, while over plowed areas this material has been incorporated with the surface soil to the depth of plowing with a resultant grayish-brown color. On the typical soil a moderate number of stones and boulders are found on the surface and through the soil, but these are not so numerous as to interfere seriously with cultivation. A variable per cent of gravel occurs in the surface and upper subsoil in places, but such material is more often found in the lower subsoil. The most important variation in this soil is in connection with its stoniness. Where stones and boulders were found to be sufficiently numerous to interfere materially with cultural operations such tracts were indicated separately on the soil map. In a few places the land is so rocky that the removal of the stones would be too costly to be carried out, and the land will be used largely for pasture. Such tracts, however, are of very limited extent.

Topography and drainage.—The topography of this soil varies from gently rolling to rolling, and while the type occurs on

some of the largest and highest hills, steep or abrupt slopes are uncommon. Practically all of the land can be placed under cultivation except the extremely stony tracts mentioned above. The drainage conditions are excellent.

Origin.—The Kennan loam is a glacial soil formed from material left by the Late Wisconsin Ice Sheet. The rocks are nearly all granitic and the soil is in an acid condition.

Native vegetation.—The original stand of timber was maple, hickory, birch, oak, and a small amount of white pine.

Agricultural development.—This is considered one of the strongest and most fertile soils in the county and is well adapted to general farming and dairying which are the important lines followed. Most of the land is improved and under cultivation. Good yields of all the ordinary farm crops can be produced. Hay is an important crop, and good pastures are readily maintained. Large yields of corn and potatoes are common. Small farm orchards, especially of apples, do well, and strawberries and bush berries make very satisfactory returns.

This soil is somewhat heavier to work than lighter members of the Kennan series, but a good tilth can be secured without difficulty. The heaviest portion of the type occurs chiefly as broad topped hills south of Polonia and in the vicinity of Benson's Corners and Amherst. More care must be exercised in cultivating this heavy phase than the remainder of the type.*

ANTIGO LOAM

Extent and distribution.—This type is mapped principally in the eastern part of the county, chiefly in the towns of Alban, New Hope and Amherst. It occurs in areas mostly less than 1 square mile in extent. The total area is approximately 5,000 acres.

Description.—The Antigo loam to an average depth of 12 inches consists of a brown or buff loam. The surface soil may be underlain by several inches of lighter colored sandy loam or loam, or may grade into a brown, compact, gravelly clay or sandy loam, which changes abruptly at 24 to 30 inches or below into brown coarse sand and fine gravel, with frequent layers of

* For discussion on chemical composition and management of this soil see page 36.

coarser gravel interbedded. This type is free from large stones and boulders, but gravel and small rounded cobbles occur quite generally in noticeable quantities on the surface and through the surface soil.

A silty variation of the Antigo loam occurs on the high glacial terrace along the valley of Waupaca River, in townships 22 and 23, range 10. If this soil were of sufficient extent it would be mapped separately as the Antigo silt loam. The soil of this variation to an average depth of 8 inches consists of a grayish-brown silt loam resting upon a buff-colored silt loam, which changes at a depth of 14 to 16 inches to a light-brown compact silty clay loam. This heavy subsoil may continue to a depth of over 36 inches or it may change abruptly at any depth below 24 inches to a brown coarse sand mixed with well-rounded gravel. Over the greater part of its extent this soil is quite uniform. In sec. 1, T. 22 N., R. 10 E., just south of where the Minneapolis, St. Paul & Sault Ste Marie Railway crosses the eastern boundary of the county, the surface soil is decidedly darker than typical.

Topography and drainage.—The type occupies flat or slightly undulating terraces, which are frequently dotted with pits and potholes. The natural surface drainage and underdrainage are good. In places where the terraces are badly eroded and where the potholes are so numerous as to produce a rolling surface, the soil is mapped with the Kennan loam, being separated chiefly because of the difference in topography.

Origin.—The Antigo loam is an alluvial soil having been deposited as outwash plains and as stream terraces. Many of these terraces are high above the bed of the present day streams. The material has been derived largely from granitic rocks and the resulting soil is all acid.

Native vegetation.—The original timber growth consisted of oak, maple, elm, and hemlock with some white pine. Practically all timber has been cut.

Agricultural development.—Antigo loam is a desirable soil agriculturally. By far the greater part of it is under cultivation and quite highly improved.

The principal crops grown, named in the order of their importance, are hay, oats, potatoes and corn. The type of agriculture most largely followed consists of general farming, with

dairying and patato growing as the two leading branches. Hay on the average yields 1½ to 2½ tons per acre, oats 40 to 60 bushels, potatoes 100 to 200 bushels, corn 30 to 60 bushels, and silage 12 to 16 tons. Little difficulty is experienced in working up a good seed bed. Stable manure is practically the only fertilizer used, but in a few instances green manuring has been practiced.

Land values on this type range from $60 or $75 to about $100 an acre, the price depending upon the location of the farm, the acreage under cultivation, and the improvements.*

KENNAN FINE SANDY LOAM

Extent and distribution.—The Kennan fine sandy loam is one of the important and extensive types of the county. It is confined chiefly to the eastern portion of the county, the largest tracts being found east of the Plover River and north of the Soo Railway line. With it are associated other soils of the Kenman and Antigo series, and in the low places small areas of past are common.

Description.—The surface soil to an average depth of 14 inches consists of a buff colored or yellowish-brown heavy fine sandy loam of a friable structure. The surface 1 or 2 inches of virgin areas is dark gray in color due to the accumulation of considerable organic matter. Over plowed areas this material has been distributed through the surface soil to the depth of plowing with a resultant grayish brown color. The surface soil grades into a subsoil of brown or reddish-brown compact sandy loam, fine sandy loam or sandy clay which passes at 20 to 24 inches or below into gravelly sandy loam or gravelly sand of the same or lighter color. A small amount of gravel frequently occurs in the surface soil and upper subsoil, but this material is concentrated mainly below the heavy stratum in the subsoil. A few stones and boulders of moderate size are found here and there over the surface of the typical soil and through the soil profile, but not in sufficient numbers to interfere seriously with cultivation.

This soil is quite uniform throughout its extent, except that there is a wide variation in the stoniness. In places the stones

* For discussion on chemical composition and management of this soil see page 36.

are so large and numerous as to seriously interfere with cultivation, and to remove them would be very difficult and expensive. Such extremely stony areas have been indicated on the map by means of symbols. In these stony tracts there is more gravel in the subsoil than where but few stones are found.

Topography and drainage.—The surface of this soil ranges from gently rolling to rolling, and because of the surface features and the gravelly condition of the subsoil, the natural drainage is good. The soil retains moisture well and therefore suffers less from drought than most other soils of the county.

Origin.—The Kennan fine sandy loam is a glacial soil of the Late Wisconsin Glaciation. It has been formed largely from granitic rocks and is in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of maple, birch, basswood, oak, hemlock, balsam, and pine. Most of the good timber has been cut, and the land which is not under cultivation is either covered with a second growth of poplar and other trees or with trees of but little value except for cord wood.

Agricultural development.—The greater proportion of the Kennan fine sandy loam is improved and under cultivation. It is one of the most desirable soils in the County and is well adapted to general farming, and especially to the dairy industry. The chief crops grown and the average yields obtained are potatoes 150 bushels, corn 35–50 bushels, rye 20 bushels, oats 30–40 bushels, barley 25 bushels and hay about 1½ tons per acre. Apples and small fruits are grown on many farms, but usually for home use only.

Where boulders are not plentiful this soil is comparatively easy to handle. It can be cultivated under a rather wide range in moisture and good tilth and maintained without difficulty. A rotation quite common on this consists of corn or potatoes, followed by a small grain seeded to timothy and clover. Hay is usually cut two years before the land is again plowed for a cultivated crop. The field may be pastured for a year before being plowed. Stable manure is most often applied to sod land.

Farms of this type of soil sell at from $40–$75 or more per acre depending upon amount of land cleared, on the improvements and the location.*

* For discussion of chemical composition and management of this soil see page 36.

PL. I. SURFACE FEATURES OF [illegible] FINE SANDY LOAM

COLBY FINE SANDY LOAM

Extent and distribution.—This soil is found only in the northwestern part of the county chiefly in the towns of Eau Plaine, Carson, and Dewey. It covers a total area of approximately 35 square miles, but no one continuous tract is over 5 or 6 square miles in extent

Description.—The surface of this type to an average depth of about 8 inches consists of a dark brown to grayish-brown fine sandy loam or sandy loam, which contains a fair amount of organic matter. This is underlain by a yellow or yellowish-brown fine sandy loam to a depth of over 3 feet. Sticky layers of clay or of compact fine sand or sandy loam occur in the subsoil. Angular rock fragments occur on the surface or are mixed with the soil. The underlying crystalline rocks are sometimes encountered within the 3 foot section, while in other places partly weathered rock occurs at about 3 feet from the surface. A marked variation is found in the subsoil in Sections 28, 29, 30, 32, and 33 in Township 24 N., R. 7 E., where a heavy red clay is found at about 12 to 36 inches beneath the surface. Variations in stoniness also are found, the most stony areas being indicated on the soil map by symbols.

Topography and drainage.—The surface varies from level to gently undulating or sloping and the natural drainage is deficient. The type is found as gentle slopes or level strips bordering streams, swamps or drainage swales, which are kept more or less permanently wet by springs, seepage and run-off from higher lying land. Some of this soil includes elevated areas of fine sandy loam which have very gently undulating to flat topography. While these areas are better drained than the low lying tracts, they are still deficient in this respect.

Origin.—This type of soil is largely of residual origin, and in this respect differs from typical soils. While the region was traversed by an early ice sheet, the resulting influence on the soils was very slight. All of the material came from crystalline rocks and the soil is now quite strongly acid.

Agricultural development.—Probably about half of the type is cleared and improved. The better drained areas are cultivated to the general farm crops common to the region, and the wettest portions are used for pasture. The best crops are se-

cured during dry years. The poorly drained condition makes the soil cold and backward in the spring. The chief crops grown are hay, oats, corn and some potatoes. Average yields are somewhat lower than on higher lying better drained soil of the same texture.

The methods of farming followed are not those best adapted to permanently improve the soil, but little attention being given to rotations and tillage best adapted to it.*

MARATHON FINE SANDY LOAM

Extent and distribution.—The Marathon fine sandy loam is confined to the northwestern portion of the county, being found chiefly in Eau Plaine and Carson Townships. It covers an area of about 21 square miles.

Description.—The surface soil of this type to a depth of 10 inches consists of a dark brown to grayish-brown fine sandy loam. The subsoil consists of a yellowish-brown fine sandy loam to 36 or 40 inches. A layer of sandy loam or loamy fine sand on sticky sandy clay and crumbly disintegrated rock may be found below 2 feet in some borings. The subsoil often varied in color depending upon the color of the rock from which derived. Granitic rock fragments and quartz pebbles of small size are often scattered on the surface. The soil is subject to numerous variations, all of which are limited in extent.

Topography and drainage.—The topography is undulating to gently rolling. The rather sandy subsoil and the rolling surface make the drainage conditions nearly perfect except in a few of the more nearly level areas.

Origin.—This soil has been formed largely from the weathering of the underlying crystalline rocks, and the variations in texture are due to the difference in the rock from which the soil was formed. While this is considered to be a residual soil, the region has undoubtedly been at least slightly effected by glacial action, but this has had no appreciable effect on the soils.

Native vegetation.—The original timber growth consisted largely of hemlock, balsam and maple, with which there was varying amounts of white pine.

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* For discussion of chemical composition and management of this soil see page 36.

Present agricultural development.—A large proportion of this soil is improved and under cultivation. It is of good quality and adapted to all general farm crops grown in this region. Small grains, corn, and potatoes do well, and hay and pasture can be furnished so that dairying is coming to be the leading industry. The soil dries out earlier in the spring, it is easier to cultivate and work and it can be worked under a wider range of moisture conditions than the heavier soils.*

ANTIGO FINE SANDY LOAM

Extent and distribution.—The Antigo fine sandy loam is of limited extent and occurs in areas of from a few acres to about one square mile in extent. It is confined largely to the east central part of the county, with the largest tracts located in sections 5 and 6 of Lanark Township. Several other tracts are found along the Wisconsin River near the northern borders of the county. The total area is about 16 square miles.

Description.—The surface soil on this type to an average depth of 10 to 12 inches consists of a grayish-brown to brown fine sandy loam. There is only a moderate amount of organic matter in the surface soil which shows some acidity. The subsoil begins as a yellowish-brown fine sandy loam and changes at 20 to 24 inches to a brown compact gravelly clay loam. This compact stratum may extend to a depth greater than 36 inches or it may pass abruptly into stratified sand and gravel at 30 inches or below. This type, like all of the Antigo soils, is free from large stones and boulders, but a noticeable amount of gravel and cobbles is commonly found on the surface and in the subsoil. Ordinarily the soil is quite uniform in its characteristics, but some variation in the texture of the surface soil was noted. In the southeastern part of the county several tracts are finer in texture than typical, while in the vicinity of Benson's corners some of the type approaches a loam in texture. The boundary line between this type and Waukesha fine sandy loam is frequently an arbitrary one. As the latter type is approached the Antigo fine sandy loam gradually becomes darker in color. The portion of the type along the Wisconsin River has a chocolate brown color, contains considerable very

* For discussion of chemical composition and management of this soil see page 36.

fine sand, and a smaller amount of gravel than is found in the typical sand. The depth to sand or stratified sand and gravel is also less than in the typical soil.

Topography and drainage.—The surface is level to very gently undulating, sometimes having a very gentle slope toward the stream along which it occurs. It usually occupies a position well above all the flood plains, and because of the open character of the subsoil the natural drainage is excellent. Along the Wisconsin River the type is lower than elsewhere, and in a few instances the lowest portion has been flooded during extremely high water.

Origin.—This soil is of alluvial origin and occurs as stream terraces or outwash plains. It has been derived largely from crystalline rocks and carried to its present position through the action of running water.

Native vegetation.—The original timber growth consisted of pine and hardwood mixed. In some places the pine predominated, while in others the hardwood was the chief tree growth with hemlock also occurring to some extent.

Present agricultural development.—Antigo fine sandy loam is considered one of the most desirable soils in the county, though few farms are located entirely upon it. It is highly improved, and is well adapted to all of the general farm crops grown in the region. It is devoted chiefly to general farming and dairying, with potato growing an important branch of the farm practice. Due to the large amount of fine sand present in the surface soil it is easy to cultivate and can be kept in a good state of tilth under a wide range of moisture conditions. The surface features permit the use of all modern farm machinery.

The crops most extensively grown and the yields usually obtained are oats 35 to 60 bushels per acre, corn 40 to 65 bushels, silage 15 tons, hay 1½ to 2½ tons, barley 25 to 35 bushels, rye 20 bushels, and potatoes from 150 to 200 bushels per acre. Strawberries and bush berries for home use are grown, though the lack of good air drainage would doubtless make commercial orchards hazardous. Apple trees make a thrifty growth on the higher portions of this soil and a few well selected varieties could doubtless be successfully grown for home use.*

* For discussion of chemical composition and management of this soil see page 36.

WAUKESHA FINE SANDY LOAM

Extent and distribution.—The Waukesha fine sandy loam is of very limited extent, the largest tract occurring directly south of Arnott forming a part of Little Whig Prairie. The total area of the type is about 3 square miles.

Description.—The surface soil of this type to an average depth of 12–14 inches consists of a black or very dark brown fine sandy loam to loam, and contains a large amount of organic matter. The subsoil begins as a brown sandy loam which changes at 20–24 inches to a brown or yellowish brown compact gravelly sandy loam or gravelly clay loam. This compact layer usually extends to a depth greater than 3 feet, but it is underlain by a lighter colored stratified sand and gravel which may be encountered at or below 30 inches. There are no variations worthy of note except that the color of the soil grows lighter as the neighboring Antigo types are approached.

Topography and drainage.—The surface of this soil is level or very gently undulating. Although the downward movement of water through the soil is somewhat slow, the type in general is fairly well drained. After heavy rains, especially during the spring, water may stand on the lower places for a time. The soil retains moisture well, and crop yields are seldom diminished through lack of water.

Origin.—This soil is of alluvial origin and occurs as flat terraces along streams or as outwash plains. The dark color of the surface is due to the accumulation of decayed organic matter.

Native vegetation.—The original timber was oak, maple and some pine. Some of this land was never forested.

Present agricultural development.—This is a very good soil for general farming and all the land is improved and under cultivation. Dairying is extensively practiced, and hog raising is also an important source of income. Large yields of oats, rye. barley, clover, corn, and potatoes are obtained nearly every year. The soil is heavier to work than the sand soil, but owing to the large amount of organic matter present, a good tilth is readily secured. The strong acidity of the soil makes it highly desirable to apply lime in order to get the best results.

CHEMICAL COMPOSITION AND FERTILITY OF LOAMS AND FINE SANDY LOAMS

These soils are only a little more open in texture than the silt and clay loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than are the heavier soils.

The total amount of the plant food elements, phosphorus and potassium, is nearly if not quite as large in the Kennan and Antigo fine sandy loams as in the silt loam. However, they have rather less organic matter and this, together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of active organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of securing this result. The application of phosphorus and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

These soils wee derived from rocks devoid of lime carbonates and therefore have a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is

true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

These types of soils are well adapted to general farming and some special crops such as potatoes can also be grown to good advantage.

CHAPTER IV.

GROUP OF MEDIUM SANDY SOILS

COLOMA SANDY LOAM

Extent and distribution.—This soil with its shallow phase occupies 10.9 per cent of the county, the phase embracing less than one-tenth of the total area.

The typical soil is well distributed throughout the two eastern tiers of townships where it occurs in areas of from a few acres to several square miles.

Description.—The soil of the Coloma sandy loam to an average depth of 10 to 14 inches consists of a brown or grayish-brown, mellow sandy loam, with only a moderate content of organic matter. The subsoil is a buff-colored or yellowish-brown, light-textured sandy loam. It changes at 20 to 24 inches into a light-brown, compact, gravelly sandy loam or gravelly clay loam layer which has a thickness of 6 to 10 inches. Below this a gravelly sand extends to a depth of over 36 inches. Stones and bowlders occur in places upon the surface, but usually not in sufficient numbers to detract from the value of the type. Areas wherein stones and bowlders are so numerous that their removal presents a serious problem are indicated on the soil map by means of stone symbols.

A variation in texture occurs in this type, where the surface soil is a brown or light-brown loamy sand. This light-textured soil is confined chiefly to the region south and west of Amherst. Some eroded terraces are also included, the soil here differing from the typical chiefly in topography, although it also contains more gravel.

Topography and drainage.—The surface of the Coloma sandy loam varies from gently rolling to rolling and hilly. The roughest areas are those which are extremely stony. Because of the surface relief and the loose character of the material the natural

drainage is sometimes excessive and the type is somewhat droughty, though not as markedly so as the Coloma sand. An exception to this thorough drainage occurs in township 25, range 9, where several areas have rather imperfect drainage, even though the surface is somewhat rolling, owing to the impervious nature of the compact layer in the subsoil.

Origin.—The Coloma sandy loam consists of glacial material which was derived in part from sandstone and in part from crystalline rocks. Because of its sandy nature and high percentage of material from sandstone it has been classed with the Coloma series. All of the material forming the soil is in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of oak, maple, and white pine, the best of which has been cut.

Present agricultural development.—The greater proportion of this soil is cleared and under cultivation. It may be considered as being moderately productive with all the advantages as well as some of the disadvantages of a sandy soil. The crops to which it is best adapted are potatoes, corn, rye and truck crops. Oats and hay can be produced, but the yields are not very heavy. The methods of farming are not those best suited to increasing the fertility of the soil. Stable manure is the only fertilizer used to any considerable extent and the supply of this is inadequate. Green manuring is seldom practiced.

This soil is better adapted to potatoes than the sand types, and wherever possible such soil should be selected for commercial potato growing in preference to sand.

While Coloma sand is somewhat deficient in plant food elements it is a fair soil and can be successfully improved.

For a more complete discussion of the chemical composition and management of this soil see page 44.

Coloma Sandy Loam—Shallow Phase.—This phase is confined entirely to the northwestern portion of the county chiefly in the towns Eau Plaine and Dewey. It covers a total area of 4,928 acres.

The surface soil is similar in color and texture to the typical soil but usually not quite as deep. The subsoil to a depth of about 2 feet is also about the same, though in the shallow phase it is sometimes slightly mottled. Below 2 feet the subsoil is usu-

ally a mottled sandy loam or sometimes a gritty clay loam. This rather heavy material usually extends below 36 inches, though frequently a layer of sand and gravel is encountered below 30 inches. In a few places the subsoil below 20 inches was found to be a heavy, greasy, gritty, dark red clay.

Angular granitic stones are scattered over the surface in places. A few rounded bowlders were also noted. Extremely stony areas are shown on the map by symbols.

The surface features are very similar to the typical soil, but the natural drainage is not quite as thorough.

In origin the phase differs more from the typical soil than in other respects. The surface may be partly glacial from an early glaciation which influenced this portion of the county only very slightly. The subsoil where heavy and containing angular rock fragments is doubtless residual from granitic rocks. The depth to rock usually being less than on the typical soil has suggested the term "shallow phase".

The original timber growth was the same as on the typical soil. The same crops are grown, about the same yields obtained, and the soil has practically the same value as has the typical soil, and for these reasons they have been placed in the same type.

PLAINFIELD SANDY LOAM

Extent and distribution.—The Plainfield sandy loam is one of the important and extensive types of soil in Portage County. The largest body of this soil is an irregularly broken belt extending through the center of the county from north to south. This tract is about seven miles long and extends from north of Ellis to a point several miles south of Stockton. Several smaller areas of one square mile or more are found in Alma and Buena Vista Townships and in the vicinity of Rosholt. It covers a total area of about 52 square miles.

Description.—The surface soil of this type to an average depth of from 8 to 12 inches consists of a grayish-brown or brown sandy loam, with a rather low content of organic matter. The subsoil is a yellowish-brown loamy sand to sandy loam in its upper portion, changing at 20 to 24 inches to a brown compact gravelly sandy loam or gravelly clay loam. This may continue to a depth of over 36 inches or change abruptly to a

coarse yellow sand intermixed with layers of well rounded granitic gravel.

The chief variation in the texture of this soil is where the type joins the Plainfield sand in which the surface soil is often a loamy sand or in a few places a sand. South of Ellis the surface soil is somewhat darker than typical, but the texture is still a sandy loam. The same condition occurs to a lesser extent in a number of places throughout the type. Small amounts of gravel are found upon the surface in places and also in the upper subsoil, but as a rule the gravelly material is concentrated in the lower subsoil, chiefly below a depth of 20 inches.

Topography and drainage.—The surface of this soil is level or very gently undulating. It is largely a terrace formation which is well above the present flood plain of the streams. These terraces may occur at different elevations with steep, abrupt slopes leading from one to the other. These slopes are often quite badly eroded and in some instances erosion channels have eaten their way back into the terrace for a short distance. Where erosion or other causes have left the terrace cut up so that it has lost its level characteristics, such tracts have been included with the Coloma sandy loam.

Because of the elevated position of some areas, and because of the character of the soil and subsoil in all cases the natural drainage of this type is good. Over the lowest portions of the soil spring rains may cause small pools of water to stand on the surface for a while, but seldom as long as to delay the usual spring work. The soil, however, is usually sufficiently heavy to retain moisture fairly well and general farm crops do not suffer to a much greater extent than on the heavier types of the county.

Origin.—The Plainfield sandy loam is a water-formed soil and occurs as level stream terraces or outwash plains. It is formed from both sandstone and crystalline rocks. Most of the gravel especially that in the subsoil is of these latter rocks.

Native vegetation.—The original stand of timber was white oak, red oak, maple, elm and some white pine. All of this has been cut except a few scattered wood lots.

Present agricultural development.—Practically all of this soil has been cleared and is at present under cultivation. It is considered a fairly fertile and productive soil, easy to work, and one which can be cultivated under a wide range of mois-

ture conditions. It is quite low in organic matter and in its water holding capacity and presents some problems common to all sandy soils. The leading crops grown are potatoes, corn, rye, and barley. Potatoes form the leading cash crop, and much of the land is devoted to the growing of potatoes. Soy beans have been successfully grown, and where the soil has been limed and manured good yields of alfalfa have been secured.

This is one of the most desirable extensive soils in the state for the commercial growing of potatoes. Having some silt and clay present in the subsoil it retains fertilizers and moisture much better than the sand types, and is easier to improve. While it is somewhat deficient in plant food, this defect can be corrected quite readily. For a more complete discussion of the chemical composition and management of this soil see page 44.

WAUKESHA SANDY LOAM

Extent and distribution.—The principal area of Waukesha sandy loam occurs in the vicinity of Almond where it forms an extension or part of the Grand Prairie which lies to the south in Waushara County. A smaller tract is found north of Arnot. The total area is 5,440 acres.

Description.—The surface soil is a sandy loam ranging in depth from 8 to 16 inches. It is dark brown to black in color when moist, and dark gray to dark grayish-brown when dry. This soil was originally a prairie and the dark color is due to the high content of organic matter. The surface soil is underlain to a depth of 18 to 24 inches by a brown sandy loam where it passes into a brown, compact, gravelly sandy loam, or gravelly clay loam. This compact stratum may extend to a greater depth than 36 inches, but it is usually underlain at a depth of 30 inches or over by sand and gravel. This sand and gravel is distinctly stratified and the change from the overlying material to it is almost always very sharp and abrupt. No important variations exist except that the line between the Waukesha sandy loam and the associated Plainfield types is usually somewhat indistinct.

Topography and Drainage.—The soil occurs as level outwash plains or as terraces in a succession of bench levels which vary in topography from level to very gently undulating. The natural drainage is excellent, and in places excessive water will some-

times stand for a time in low places in the spring or during continued rainy periods. The soil retains moisture fairly well, and crop yields are more certain than on the sand soils.

Origin.—This is a water laid soil and consists of stream terraces, outwash plains or filled in valleys. The dark surface soil is due to an accumulation of decayed organic matter, largely prairie grass.

Native vegetation.—Most of this soil was originally treeless and covered chiefly with prairie grass, however, there was a scattered tree growth about the margins of the prairie in a number of places. This consisted of red, black, and white oak and some white pine.

Present agricultural development.—Practically all of this soil is improved and under cultivation. Dairying is the leading industry followed with potato growing as an important branch of farming. The soil is easy to work and can be cultivated under a wide range of moisture conditions. It is one of the best corn soils in this county. Good yields of all common farm crops are produced, although the chief crops are corn, potatoes, rye and hay. The farms and buildings have a prosperous and well kept appearance, and the price of this kind of land is as high as of any land in the county.

While this soil is acid and needs lime, it can be readily improved. For a discussion of the chemical composition and management of Waukesha sandy loam see page 44.

BOONE SANDY LOAM

The Boone sandy loam covers only about 3 square miles and is confined to the country west and southwest of Stevens Point on the west side of the Wisconsin River, chiefly in Linwood Township.

The surface soil to a depth of 8 to 12 inches is a brown sandy loam underlain to about 20 to 24 inches by a light-textured, yellowish-brown sandy loam. The subsoil from 20 to 24 inches to over 36 inches is a yellow sand except where the Potsdam sandstone is reached, as is the case in a few instances. Slabs and fragments of this parent rock occur on the surface and through the soil profile, though usually not in great numbers.

This type varies from undulating to gently rolling. The surface drainage is fairly good, but the underlying sandstone

rock frequently comes to within 2 or 3 feet of the surface and this sometimes produces rather imperfect underdrainage. The overlying soil has the ability to absorb a large amount of water, but the sandstone is less pervious and the water will follow this rock stratum with a resultant springy condition over areas where the surface material is shallow or on slopes where the horizontal rock strata come close to the surface. In such localities the surface soil is usually somewhat darker than typical and the subsoil mottled more or less with drab, yellow and rusty brown.

The methods of farming and the crops grown on this type are practically the same as those for the Plainfield sandy loam. The Boone sandy loam, however, has a lower agricultural value.

CHEMICAL COMPOSITION AND FERTILITY OF MEDIUM SANDY SOILS

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn, and potatoes, find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds in the surface 8 inches per acre. The total potassium of the surface 8 inches per acre is 25,000 to 30,000 pounds or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2 per cent in the second 8 inches. They have a correspondingly low nitrogen content, averaging from a thousand to 1,500 pounds in the surface 8 inches and from 500 to 800 pounds in the second 8 inches. As indicated by its dark color, the Waukesha sandy loam contains somewhat more nitrogen than the other types of the group, but this frequently quite resistant and not readily available.

The most important point in the management of all these soils is to follow methods which will maintain and increase the

organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other live stock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soy beans or clover, occasionally, to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil productivity. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover and there is little loss in so doing, since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The liming and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils it must not be considered that this is an indication that they

have less value, than heavier soils which are relatively higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these sandy loams develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. This group of soils is well adapted to the commercial growing of potatoes, and whenever possible the sandy loams should be seleted for this crop in preference to sand types. A good rotation for these sandy loam soils consists of small grain, clover and potatoes. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204 and 230 of the Experiment Station.

CHAPTER V

GROUP OF SAND SOILS

PLAINFIELD SAND

Extent and distribution.—The Plainfield sand is one of the most extensive soil types in Portage County. The greater proportion is found in the central and southwestern portions of the county in the vicinity of and to the south of Bancroft, south of Plover, and about Arnott. One large tract is confined to the valley of the Wisconsin River, chiefly between the river and the Buena Vista marsh. Small patches are also scattered throughout the eastern portion of the county.

Description.—The surface soil of this type to an average depth of 10 inches consists of a brown or grayish-brown sand. The subsoil is a yellowish-brown sand which becomes coarser, lighter in color, and more gravelly with increased depth. Below about 24 inches the sand and gravel is very distinctly stratified and has a marked yellow tinge.

The soil as a whole is quite uniform, but a few slight variations occur. In small depressions there is more organic matter than usual, and this gives the material a slightly loamy appearance. In the southwestern part of the county there is a large proportion of quartz grains in the sand, while in the central part of the county the feldspathic materials from granitic rocks are more abundant.

The line drawn between this type and the Plainfield sandy loam is somewhat arbitrary. Usually as the sandy loam is approached the surface soil becomes somewhat more loamy, and in small slightly depressed areas there is a sticky layer in the subsoil at a depth of 20 to 24 inches. Small areas differing little in topography from the remainder of the type and situated well within its general development are frequently somewhat darker in the surface soil than typical.

Topography and drainage.—The surface of this soil is level or very slightly undulating. Because of the loose character of both the soil and subsoil the drainage is excessive except in places where the water table comes close to the surface or along the border of marshes. Crops suffer from lack of water over most of the type unless the rainfall is heavy and very regularly distributed.

Origin.—The Plainfield sand is of alluvial origin and has been formed by the water of the Wisconsin River or deposited as outwash plains by the streams of glacial times. Being assorted by running water, the finer soil grains were carried away, leaving the coarser sand grains deposited in horizontal layers. The parent material came both from sandstone and granitic rock formations. All of the soil is acid.

Native Vegetation.—The original timber growth consisted of scrub oak, red oak, some white oak, Jack pine, some white pine and sweet fern. The Jack pine was the most common.

Present agricultural development.—Most of this land has been cleared and placed under cultivation. This is due, no doubt, to the ease with which it can be cleared rather than to the fertility and productive qualities of the soil. Abandoned farms are not unusual, especially in the valley of the Wisconsin River, and fields sometimes remain idle for several seasons at a time. The chief crops grown at present are potatoes, corn, rye, oats and some hay. Soy beans have been grown both for forage and for seed with good results, though not on an extensive scale. Where difficulty has been experienced with clover, soy beans have been grown instead. Both are legumes, and the soy bean seems to be adapted to the conditions prevailing on the Plainfield sand. Potatoes and rye are the chief cash crops, the other crops being grown mainly to feed the dairy cow. The yields of all crops are considerably less than the yields produced on the heavier soils of the county. The difficulty in maintaining good pasture and in growing sufficient hay for feed prevent the development of the dairy industry to such proportions as on the heavy soils.

While potatoes are grown quite extensively, the Plainfield sand is not as well adapted to this crop as are the sandy loam soils. Corn will show greater increase in yields as this soil is improved than will potatoes, and corn should therefore be grown more extensively than potatoes.

Plainfield sand is deficient in the plant food elements and its successful cultivation requires special care. A more complete discussion of the chemical composition and management of this type will be found on page 54.

COLOMA SAND

Extent and distribution.—The Coloma sand is confined to the eastern half of the county where it is associated with other types of the Coloma series. It occurs in numerous small tracts instead of extensive, continuous areas. This type covers a total area of about 118 square miles.

Description.—The surface soil of this type to a depth of 6 to 10 inches consists of a brown or grayish, rather loose sand of medium texture, which in local areas approaches a fine sand. Over some areas of virgin soil the surface 1 or 2 inches is somewhat darker than usual owing to a small accumulation of organic matter which usually disappears after being cultivated for a few years.

The subsoil consists of a yellowish-brown or light brown sand of medium texture which usually becomes lighter in color and coarser in texture with increasing depth. A small amount of gravel may be found in the surface portion of the type, but such material occurs with greater prominence below a depth of 24 inches.

The number of stones and bowlders present is variable and in some localities they are sufficiently numerous to justify a separation on this basis. Wherever the stones and bowlders were found to be sufficiently abundant to interfere with agricultural operations such areas were indicated separately on the soil map by appropriate symbols. Where this stony, bowldery condition prevails, there is often more variation in the texture of the soil material than over the typical portion of the type. The surface over limited areas may be a sandy loam, and in the subsoil a compact sandy loam stratum about 6 inches in thickness may occur at a depth of 18 to 24 inches. Such variations, however, were only very small and could not be shown separately.

Topography and drainage.—The surface of the typical soil varies from undulating to gently rolling. There has been included some rather steep slopes where there is a drop from one terrace to another. While this class of land is not typical for

Coloma sand it has been included because of its limited extent and because it has about the same agricultural value. The portion of the type indicated as covered with stones and bowlders is rougher than the typical and includes the roughest land in the county. The surface varies from rolling to hilly and broken with only a few small tracts that are of the same topography as the typical soil.

Because of the loose open character of the material and the surface features, the natural drainage is excessive and the soil is droughty. Highest yields are received during years of most abundant rainfall.

Origin.—Coloma sand is a glacial soil derived largely from sandstone but in part from granitic rocks, by the action of the ice sheets. The sand grains consist chiefly of particles of quartz with a mixture of varying amounts of material from dark colored rocks. The stones on this soil are not of sandstone but have been brought in from the north by the glaciers. Practically all of the soil material is acid.

Native vegetation.—The original timber growth was very thin and of poor growth, consisting of Jack pine and scrub oak.

Present agricultural development.—Probably the greater proportion of the typical soil is cleared and under cultivation, but most of the stony part is still in timber and used for pasture. Land of this type is of a lower value than most of the other classes of land in the county due to its sandy nature and low fertility.

The type of agriculture most extensively followed consists of general farming with potato growing given most prominence. Dairying is practiced to a smaller extent than on the heavier soils of the area. The chief crops grown and average yields obtained are potatoes 75–125 bushels per acre, rye 8–15 bushels, oats 15–25 bushels, corn 15–30 bushels, hay ½ to 1 ton and buckwheat 12–18 bushels. Much depends upon the amount and distribution of rainfall, the manure applied or legumes plowed under. The type is easily run down by continuous or improper cropping. The soil is easy to cultivate but the methods which are followed are usually not those best suited to building up the fertility.

The yields of corn can be more readily increased on this soil than can the yields of potatoes, and for this reason more corn

and less potatoes should be grown. Potatoes are better adapted to the sandy loam soils.

For a full discussion of the chemical composition and management of this soil see page 54.

Coloma sand—shallow phase.—This phase covers a total area of only 5,440 acres and is confined to the northwestern part of the county in Townships 24 and 25 N., Ranges 6, 7 and 8 E. It occurs as patches, knolls and stripes of upland, often bordering streams or lying in the vicinity of marshes. The largest single area is on elevated, undulating to rolling bluffs or knolls in the vicinity of the Wisconsin River to the east and northeast of Junction City.

The shallow phase is quite similar to the typical soil in the surface and upper subsoil. In the lower subsoil, however, coarse angular rock fragments occur in places and frequently there is sufficient clay to make the material slightly sticky when wet. This deep subsoil is also varied in color and often rests upon granitic rocks at depth of about 3 feet, while the typical soil usually extends to a much greater depth.

On areas of this type along Mill Creek in T. 24, R. 6 E., occasional granitic bowlders may be found lying on low knolls or slopes of deep sandy soil. On the large area 3 miles north of Junction City and the areas east and northeast of Junction City in the vicinity of the Wisconsin River the soil is thickly covered in places with angular blocks and fragments of granitic rocks. In Section 9, T. 24, R 7, E., these fragments and blocks also occur in the subsoil and grade into the underlying rock. In some instances a few rounded granitic bowlders are found, especially on areas near the Wisconsin River.

In topography and drainage conditions the phase corresponds closely with the typical soil.

In origin the lower subsoil is largely residual while the surface may be partly residual and partly glacial from material deposited by one of the early ice sheets.

In agricultural value, present crop yields and systems of farming followed there, is practically no difference between the shallow phase and the typical soil.

WAUKESHA SAND

Extent and distribution.—Waukesha sand is an important type from the standpoint of the area which it covers. It is confined largely to the valleys of the Wisconsin and Plover Rivers. The largest body begins at Plover and extends north about 15 miles up the Plover River. Along the Wisconsin River it occurs mostly on the east side. It covers a total area of about 34 square miles.

Description.—The surface soil of this type to an average depth of 6 to 8 inches consists of a dark brown or dark gray sand or loamy sand which appears nearly black when moist. The content of organic matter is greater than in the Plainfield sands with which it is associated.

The subsoil begins as a brown or light brown, loose, open sand which becomes lighter in color and somewhat coarser in texture with increasing depth. A limited but variable percentage of small rounded gravel is commonly found in the subsoil at and below a depth of 20 to 30 inches. The deep subsoil is stratified, thin beds of fine and medium sand alternating with coarser textured material. Both soil and subsoil show varying degrees of acidity. The surface is stone free.

While the type as a whole is quite uniform, there are a few minor variations worthy of note. In Section 5, T. 24, R. 8 E., the surface soil is somewhat coarser than typical and contains a small amount of angular gravel. West of Jordan the surface is slightly undulating and the soil is variable in color within short distances. The irregularities of the surface appear to be due to wind action and the higher places are usually lighter colored in the surface soil than the depressions.

Topography and drainage.—The surface of this soil type is for the most part level with only a few knolls which have been caused by the wind. Because of the loose, sandy nature of the soil, crops suffer from lack of moisture during some part of every season.

Origin.—This soil has been formed by water action and consists of stream terraces, outwash plains, or filled in valleys. The characteristic feature and the one which distinguishes this from the Plainfield sand is the dark surface soil and the resulting higher content of organic matter.

Native vegetation.—A portion of this soil was originally without trees and is spoken of as prairie. The growth and decay of grasses gave the soil its dark color. Over smaller tracts and on the border of the larger areas, white pine was found. All of this has been cut, and the land now has the appearance of a sandy prairie.

Present agricultural development.—While this soil is not as extensive as some other types in the county, it is especially well located and for this reason is of greater importance agriculturally than if distinctly removed from cities or transportation facilities. The greater proportion of this soil has been cleared and placed under cultivation, but because of low yields, fields are frequently abandoned or allowed to remain idle for several years at a time.

The chief crops grown are potatoes, corn, rye, oats, buckwheat and hay. General farming is the leading type of agriculture followed, but dairying and hog raising are not nearly as extensively developed as in regions of heavier soils in this and adjoining counties.

Average yields of all general farm crops grown are small. During seasons of abundant or well distributed rainfall, fair to good yields may be secured. Near Stevens Point some trucking is carried on and where the soil is given the best of management profitable returns are secured. The soil does not wear well, however, and frequent fertilization is necessary in order that pofitable yields may be secured from year to year.

Because of its loose open structure, this soil is easy to cultivate. Difficulty is experienced in getting clover started, chiefly because the soil is acid and partly because of its low fertility and droughty condition. Practically the only fertilizer used is stable manure, some of which is secured in Stevens Point. But little stock is kept on the average sand farm.

While potatoes are doubtless the most important crop grown at present, this soil is not especially well adapted to potatoes. It has been found by test that the yields of corn can be much more readily increased on this kind of soil than can the yields of potatoes. The acreage of corn could well be extended and silage used for summer feeding of stock. This would permit a reduction of the acreage devoted to pasture, which would be desirable, since such soil does not produce good pasture.

CHEMICAL COMPOSITION AND FERTILITY OF SAND SOILS

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing periods. But when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of the growing crops and they therefore suffer from drought. Moreover, some sandy soils are lower in their supply of the chemical elements demanded by crops than heaver soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as fine sands or sandy loams have fairly good water-holding capacity, and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of and they can be farmed with profit. But soils which are classified as sands, such as the Coloma and Plainfield sands, are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain. The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or fineness of grain and cannot be affected by any treatment it is practicable to give them. The water-holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparatively slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in these soils is moderate. The total phosphorus in the surface 8 inches per acre averages between 750 and 900 pounds and in the second 8 inches between 600 and 700 pounds. The total potassium i nthe surface 8 inches per acre is 25,000 to 30,000 pounds in comparison with 50,000 or 55,000 pounds in the silt loam soils of that region. The total nitrogen content is between 1,200 and 1,400 pounds in the surface 8 inches per acre. The

Waukesha sand, as its dark color indicates, contains slightly more nitrogen than the other soils in this group.

When a sufficient supply of active organic matter is developed in these soils a considerable portion of the phosphorus and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed.

The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. But before legumes can be grown with the greatest success the liming of the soil is necessary. The growth of a good crop of mammoth clover or soybeans through the use of lime and mineral fertilizers coitaining phosphorus and potassium is the best means of supplying this nitrogen and organic matter. In most cases this legume should be plowed under as a green manuring crop.

Probably the best way to get clover started is to seed with a small grain. By using a light seeding of rye, disked or harrowed in and seeded to clover in the spring, a good stand can usually be secured. The seed should be put in a little deeper than on heavy soils, and the drill should be followed by a corrugated roller, or if this implement is not at hand, and ordinary roller, followed by a light harrow should be used. When clover is seeded with a small grain in this way the growing grain helps to hold the soil in place and prevent blowing of the loose soil by the wind.

As the result of careful experiments on extremely sandy soils it appears that the best crop rotation for this class of land consists of rye, clover, and corn. If the fertility is extremely low, it will be advisable to plow under the entire clover crop. If the fertility is fair the first crop may be cut for hay and the second plowed under. While potatoes are quite extensively grown on these extremely sandy soils this crop is not as well adapted to the sand soils as to sandy loam types. It has been shown by actual field tests that the yields of corn, for example, can be more readily increased on the sand soil than can the yield of potatoes. The potato when grown on sand soil does not respond to methods of soil improvement as readily as when grown on soils which contain somewhat more silt and clay. The sandy

loams and fine sands and fine sandy loams are much better adapted to potato culture than are the sand soils. It is therefore advisable to reduce, where possible, the acreage of potatoes on sand soils.

With an increased acreage of corn it will be possible to put up enough silage so silage may be used for summer feeding. With this practice less pasture will be required, and this again will be desirable since the sand soils do not supply good grazing, and are not well adapted to any of the grasses. This system would make possible keeping more stock, and with the increased supply of manure the fertility of the land could be more readily maintained.

CHAPTER VI.

GROUP OF POORLY DRAINED SOILS.

PEAT

Extent and distribution.—From the standpoint of area covered, Peat is the most extensive soil type of the county. By far the largest tract is found in the southwestern portion of the county. This is known as the Buena Vista Marsh and covers a total area of over two townships. Another extensive marsh area is found in the northwestern part of the county, chiefly in Eau PlaineTownship, and is a part of the Dancy Drainage District. This marsh extends for over 10 miles along Little Eau Plaine River, but only a small proportion of it is within the area surveyed. A considerable proportion of this marsh consists of peat. Another peat marsh is found immediately east from Jordan, and extending north from Stockton for over 6 miles. It has a width of about one mile. Numerous other small peat marshes occur through the northern and eastern portions of the survey.

Description.—The material mapped as Peat consists of decaying vegetable matter in varying stages of decomposition with which there has been incorporated a small amount of mineral matter. When raw and fibrous, and only slightly decomposed, the Peat has a brown color, but when more completely decayed it becomes darker and is sometimes black. It is light in weight as compared with other soils, and is loose and rather spongy. The surface material is often of a lighter brown color than that found at a depth of 2 feet or over. This is usually true of the timbered marshes in the region of glacial soils. In some instances the more thoroughly decomposed material occurs at the surface and raw fibrous peat is found at lower depths. This appears to be the case most frequently where marshes were originally treeless.

The material mapped as Peat ranges in depth from 18 inches to over three feet. Where less than 18 inches it has been classed as shallow peat and mapped separately. Probably about 1/3 of the deep peat has a depth of over 3 feet. In some instances the peat is known to be over 10 feet in depth. The material found beneath the peat usually consists of gray or nearly white sand of medium texture. In the northwestern part of the county where some of the upland soils are heavy, the underlying material is sometimes a clay loam or sandy clay. This is also true of some of the marshes in the eastern half of the county, especially in the northeastern section, where some of the marshes are surrounded by heavy soils. Where the marshes are surrounded by sandy soils the peat is usually underlain by sand, and where the upland bordering the marsh is heavy the material under the marsh is usually heavy also.

Topography and drainage.—The surface of all Peat areas is low, level, water soaked, and naturally very poorly drained and before farming the Peat must be reclaimed by some drainage system. A large proportion is included within drainage districts and has been drained more or less thoroughly by large open ditches which in some cases have been supplemented by tile drains.

Probably the most important factor determining the value of marsh land will be the crops which can be grown on it. This depends on two factors, first the degree of drainage, and second the danger from frost. When only the main outlet and lateral ditches have been installed, in the great majority of cases, hay crops are the only ones which can be safely grown, and the character of the hay will also depend a good deal on the character of the drainage. In the case of peat land underlaid by sand, the drainage by well constructed and sufficiently deep ditches 40 to 80 rods apart will, in most cases, give adequate drainage for hay. When the peat soil is underlaid by silt or clay, however, ditches not more than 20 rods apart will be necessary and these must lower the water in the ditch to a point four to five feet below the surface during part of the growing period. When tilled crops, such as corn, cabbage, or potatoes, or small grains are to be grown, the drainage must be more certain, and over the greater portion of our marsh lands this will mean the installation of dainage systems in the form of

either open lateral ditches or of tile not more than ten and often not more than five rods apart on the average. Tile drainage is the more satisfactory. The cost of tile drainage will vary from twenty to thirty dollars per acre after the main outlets have been put in.

Frosts on marsh land.—It is well known that frosts frequently occur on marsh land where there is no frost on higher land. This is partly because the cold air which forms on the surface of all the ground at night tends to flow down and collect in low places, but it is also the result of the fact that the loose, spongy soil of peat marshes does not conduct the heat received from the sun during the day downward. In consequence of this, the lower layers of soil do not become warmed in peat marshes as they do in other earthy soils and the little heat left in the surface inch or two of soil is rapidly lost at night by radiation, so that the freezing point is frequently reached on such soil when it would not be on more earthy soils such as sandy loam or clay loam which would conduct the heat downward better during the day and so keep warm farther into the night.

This difficulty with peat marshes can be overcome to a certain extent by heavy rolling which, by compacting the soil, permits the heat to be conducted downward more readily. It will also to a certain extent become less in time, as the peat decomposes and takes on more of the character of muck. Nevertheless, it must always be expected that marsh land will be more subject to late Spring frosts and early Fall frosts than high land. It may be stated as a general guide, that the occurrence of killing frosts is as liable on marsh land at any given point as it is on upland soil having good air drainage about 150 miles farther north; in other words, the marshes of Dane County are as liable to have a frost which will kill corn as early as are the upland regions of Shawano, Marathon, or Clark Counties. The marsh land regions of Portage County are liable to have frost two weeks or more earlier than the hill tops of the same latitude. This means that corn and potatoes, while safe crops for the upland region, are not safe crops for the marsh land and should not be depended on as the chief crops.

Native vegetation.—The original vegetation on the Peat marshes consisted chiefly of coarse marsh grasses, sedges and sphagnum moss on the open marshes, with willow, alder, some poplar and tamarack on the timbered tracts.

Present agricultural development.—By far the most extensive farming operations on marsh land in this county are carried on in the Buena Vista Drainage District, in the southwestern portion of the area. Approximately one-half of this marsh consists of peat, and a considerable proportion of this has been placed under cultivation. Many substantial farm buildings have been constructed here, and farming is carried on with varying degrees of success.

The chief crops grown at present are corn, oats, rye, millet, buckwheat, timothy and alsike clover, potatoes and various root crops. Where proper methods of fertilization and cultivation are followed and where the drainage is sufficient, the yields are equal to those obtained on good upland soil. In many cases, however, the necessity of using fertilizers has not been realized, and the cultural requirements have not been fully met by most of the farmers. For these reasons, and owing to the fact that in some places the drainage has not been sufficient, crop yields have often been low, and some farmers have become discouraged. Where the drainage is not sufficient for growing cultivated crops, some marsh hay is frequently cut.

In the Dancy Drainage District some development has taken place on peat land also, but only a very small proportion of this district has been improved. Drainage projects are being considered for other peat marshes in the county, and in some cases small tracts are being reclaimed by individual effort.

Peat, shallow phase.—Shallow Peat is not nearly as extensive as is the deep peat. The largest tract is in the southwestern part of the county in the Buena Vista marsh where it is closely associated with the deep peat. It usually occurs as a gradation from deep peat on one hand to the black, wet Dunning soils on the other, and the variations in the type will range between these two conditions. Besides that which is found in the Buena Vista marsh, other areas are found in the northwestern part of the county, but these are small in extent.

The material mapped under this name consists of brown to black vegetable matter in varying stages of decomposition, with which there is incorporated varying amounts of mineral matter. The type includes those areas of peat where the depth of the accumulation will average about 18 inches though it varies from about 10 or 12 inches to as deep as 22 or 24 inches in a

few instances over small areas. The peat usually rests upon a gray to white sand of medium to fine texture, though in a few instances a clay loam or sandy clay was found. This heavy material usually occurs in the northwestern part of the county where there is considerable heavy soil in the uplands adjoining the marshes.

Little development has taken place on the shallow peat outside of that of the Buena Vista marsh where the peat has been drained and improved along with the deep peat.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT

The chief difference between peat soils and upland soils consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorus in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds, or in two feet 1,350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average 0.3 per cent of this element, while good upland clay loam soils average two per cent, or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and potassium. These elements are contained in relatively small amounts in barnyard manure and good appli-

cations of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorus and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Crops and system of farming on marsh lands.—Since the growth of corn and potatoes to which these marsh lands would otherwise be well adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops, and rye, and to a less extent oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land not too raw good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

On account of the crops to which this land is adapted and its use as a pasture, marsh lands can be used for dairying or stock raising to good advantage.

Certain special crops, such as cabbage, onions, buckwheat, and rape, are well adapted to such lands when well drained and fertilized.*

DUNNING SAND

Extent and distribution.—The Dunning sand is confined largely to the southwestern part of the county, where it occurs chiefly as a marsh-border type. It is encountered bordering

* For more complete discussion of the management of marsh soils see bulletin on this subject by the Agricultural Experiment Station.

areas of peat, in shallow depressions or basin-like areas in association with the Plainfield soils, and along stream courses throughout the region where sandy soils predominate. The largest tract occurs several miles west of Coddington. The type covers a total area of about 34 square miles.

Description.—Dunning sand to an average depth of 6 to 12 inches consists of a dark-gray to almost black sand rather high in organic matter. The subsoil to over 36 inches is a dull-gray or mottled gray and yellow sand, with more or less fine, well worn gravel in the lower part. In a few places the soil is loamy in texture.

The chief variation from typical occurs in the Buena Vista Drainage district, in an irregular area which originally consisted of shallow peat overlying sand. The shallow covering of peaty material has been burned off over this area, and the resultant soil consists of Dunning sand streaked and spotted with areas over which the surface soil from 2 to 10 inches consists of a gray, yellowish-brown or dark-gray ash mixed with sand. Here and there occur remnants of shallow peat which were not destroyed by the fire. These usually stand a few inches above the level of the surrounding soil.

Topography and drainage.—The surface of the Dunning sand is level and the natural drainage is deficient. Much of the type lies within drainage districts, where the drainage conditions have been greatly improved by the construction of large open ditches. In some places these have been supplemented by tile drains.

Origin.—This type is found mostly within the valley of the Wisconsin River and is largely of alluvial origin. As it occurs within or bordering marshy districts the moist conditions have favored the growth and decay of considerable vegetable mattre which accounts for the dark color of the soil. No calcareous material is present and both soil and subsoil are acid.

Native vegetation.—The original vegetation consisted of willow, spruce, and poplar, with some jack pine in the higher places and coarse marsh grasses in open stretches.

Present agricultural development.—Because of its generally rather poor drainage this type is not of much agricultural importance. Only a comparatively small proportion of it is under cultivation.

The chief crops grown on this soil are oats, corn, potatoes and hay. Buckwheat, alsike clover, millet, and rye are sometimes grown. This soil is considered to have a low value as it is deficient in potash and phosphorus and occupies such a low position that it must all be drained by open ditches or tile drains. In some cases the outlet ditches already installed do not appear to be deep enough to permit thorough drainage.

DUNNING SANDY LOAM

Extent and distribution.—The Dunning sandy loam covers a total of about 25 square miles, but occurs in rather small scattered areas, associated chiefly with the Colby, Plainfield, and Waukesha soils. The largest single area is found in the Town of Hull and the major portion of the type is confined to the northwestern quarter of the county.

Description.—The surface of the Dunning sandy loam extending to an average depth of 10 inches, consists of a dark-brown or black sandy loam or heavy sandy loam, high in organic matter. The subsoil usually consists of a yellow or gray sand, sticky sand or sandy clay loam. It is frequently mottled. The lower subsoil is subject to considerable variation, ranging from rather heavy sandy loam to beds of quite sandy soil. Thin lenses of clay loam may also occur, and gravelly material is frequently encountered in the subsoil.

Topography and drainage.—The surface of this type is level. It is low-lying and naturally poorly drained. Open ditches already installed provide fair drainage for part of the type, and supply outlets into which tile drains may lead, but most of this soil is still in an undrained condition.

Origin.—The type occurs as first bottom lands along stream courses, as low land bordering marshes, or as slight depressions in the uplands or in terraces. As found in this county the major portion of it is of alluvial origin. The parent material came in part from crystalline rocks, but probably the major portion was derived from sandstone. There is no calcareous material present and both soil and subsoil are acid. The growth and decay of vegetation accounts for the dark color and rather high organic matter content.

Native vegetation.—The native vegetation consisted mainly of alder, poplar, with some red oak and white pine on the better

drained areas. Coarse marsh grasses also grew upon this soil.

Present agricultural development.—Because of the rather limited extent, small scattered areas, and poor drainage conditions, the type is at present of little agricultural importance. Only a small proportion of this soil is under the plow. The chief crops are hay, small grains, corn and buckwheat. The soil, when thoroughly drained, is easily cultivated and may be considered a fairly productive soil, upon which satisfactory yields can usually be secured under good management when the season is not excessively wet.

This type has a larger supply of the mineral plant food elements than are found in peat, and it is a better balanced soil than the peat lands.

WHITMAN SILT LOAM

Extent and distribution.—This type is confined chiefly to the northwestern quarter of the county where the upland soils consist largely of the Marathon and Colby series. The type also occurs to a limited extent where the upland soil is of the Boone series, but in such localities the deep subsoil is usually of a sandy nature. Where the upland soils consist of the Kennan types, small areas of Whitman silt loam may also be found. For the most part this type occurs as narrow belts along stream courses, and but few of the areas contain more than one-quarter of a square mile. The type has a total area of about 8 square miles.

Description.—The surface soil of this type to an average depth of about 12 inches consists of a dark brown or black silt loam containing a high percentage of organic matter. The subsoil consists of a heavy silt loam or silty clay loam which usually extends to a depth of 36 inches or more, and frequently becomes somewhat heavier as the depth increases. The color of this subsoil material is usually a dark gray or drab which is frequently mottled with brown or yellow or sometimes both. In the deep subsoil some fine sandy loam is frequently found, and coarser material may occur, giving the subsoil a somewhat gritty character. In a few instances beds of fine sand were found at a depth of 30 to 36 inches.

The soil as a whole is rather uniform in its color and in the

texture of the surface soil, but as indicated the subsoil may be subject to considerable variation.

Topography and drainage.—The surface of this soil is level or very gently sloping, and because of its low position and the fact that some of it is subject to overflow, the natural drainage is poor.

Origin.—The Whitman silt loam has probably been derived from several sources. It is partly of residual, partly of alluvial and partly of glacial origin. It occurs as first bottom land along streams or in depressions in the upland where there has been an accumulation of organic matter due to the wet conditions existing.

Native vegetation.—The orginal stand of timber consisted of elm, ash, alder, and other water-loving trees and grasses.

Present agricultural development.—Because of its limited extent and its poorly drained condition, this type is at present of very little importance agriculturally. Only a very small part is improved and under cultivation. Where there is sufficient fall so that drainage can be accomplished, it can be farmed with profit. The soil is naturally very productive and well adapted to all the general farm crops grown in this section. It is well supplied with all of the essential plant food elements.

GENESEE FINE SANDY LOAM

The surface soil to a depth of 16–18 inches is a brown fine sandy loam to sandy loam. The 4 to 6 inches of the immediate surface are usually darker brown than the underlying portion. The subsoil begins abruptly as a yellowish fine sand stratified in the lower portion with layers of water worn gravel. This type occurs as low terraces along the Wisconsin River usually somewhat higher than the Genesee silt loam, but subject to periodic overflow. The topography is flat to slightly undulating interrupted frequently by abandoned stream channels or sloughs. These sloughs are filled with deep peat or hold water after the subsidence of the overflows. The drainage of the type is good between inundations.

The type is of limited extent and minor importance. Most of the type is still timbered to oak, elm, basswood, maple and white pine. Where cleared and cultivated the chief crops are

rye, corn, oats, hay and potatoes. Farming on this soil is uncertain because of danger of flooding. Reports indicate that floods occur every 3–5 years sufficient to destroy all crops with less destructive floods more frequently. The small extent of this type would not justify the construction of dikes to protect the land from flooding.

GENESEE SILT LOAM

The Genesee silt loam is of very limited extent and is confined entirely to the valley of the Wisconsin River.

The surface soil to a depth of 16 to 18 inches consists of a dark brown or reddish brown silt loam. A few inches of reddish brown sandy loam may intervene between the surface soil and the underlying loose, yellow sand and gravel, but in most places the change from heavy soil to sand is abrupt. The subsoil is distinctly stratified.

The surface is flat to slightly undulating except for abandoned stream channels or sloughs. The sloughs are either filled with a deposit of peat or else hold water after the subsidence of the overflow. The drainage is good except at times of high water when the land is flooded.

This is an alluvial soil and occurs as first bottom land along the Wisconsin River, and is subject to overflow.

This soil is nearly all timbered with soft maple, elm, ash, birch, and some basswood and oak.

A few spots have been cleared, and such crops as oats, corn, hay and potatoes are grown. The danger from flooding makes farming uncertain so that the development of this land is not encouraging. To prevent flooding, dikes would be necessary, and such a great expense would not be justified under present conditions.

CHAPTER VII

GENERAL AGRICULTURE OF PORTAGE COUNTY

The development of agriculture in this region was preceded by the growth of the logging and lumbering industry. The earliest settlements, about 1840, were made in the areas of sandy land, as the forest growth here was largely pine, which was the only timber handled by the early lumbermen. Hardwood at that time had but little value, and where early clearings were made in hardwood areas the timber was frequently burned.

The first farms opened after the advance of the lumbermen were small, and often large areas of land remained in the cut-over stage for a considerable time before being parceled out in small tracts. While farming ventures were first begun chiefly on the sandier soils, following the cutting of the pine, the highest agricultural development has been reached in those sections where the soils are heavier than those immediately along the Wisconsin River. Farming has extended to all parts of the county, and on the whole it is well improved agriculturally. The sections of least development are in the north-central and northeastern parts of the county and in those regions where marshy conditions prevail over large areas.

While practically all the general-farming crops now grown were produced in the early history of the county, the relative importance of a number of the crops has changed to a considerable degree. In 1879 wheat occupied 21,853 acres, more than twice the acreage in oats. By 1909 the total area devoted to oats had increased to 37,838 acres, while only 397 acres were devoted to wheat. The acreage to hay, corn, and rye has steadily incresed since the early history of the county. The development of the potato-growing industry has been very marked. In 1879 there was a total production of 213,570 bushels, while in 1909 the crop amounted to slightly over 2,500,000 bushels.

The agriculture of Portage County at present consists chiefly

of general or mixed farming, with dairying and potato growing as the two most important branches. The chief crops grown, in order of acreage, according to the 1910 census, are hay, oats, potatoes, rye, corn, and barley, with buckwheat, wheat, peas, and beans as crops of lesser importance. While the dairy industry is important it is not as highly developed as in some of the adjoining counties where there is a larger proportion of heavy soils.

Practically all of the crops grown may be considered in part as cash crops, for hay, corn, oats, rye, and barley are sold to some extent directly from the farm. Potatoes are grown mainly for sale, although they are one of the most important subsistence crops. The greater part of the hay, corn, oats, and barley produced is used in feeding live stock, and much of it finally reaches the market in the form of dairy products, beef, and pork. A considerable quantity of grain and hay is used as feed for work stock.

Hay is grown more extensively than any other crop. The 1910 census reports 48,286 acres in all hay crops, with a production of 47,982 tons, or nearly 1 ton per acre. About 75 per cent of the tame hay grown consists of mixed clover and timothy. Little clover is grown alone. Minor hay crops are wild hay, small grains, millet, and alfalfa. The best hay crops are produced on the heavy soils of the Spencer, Gloucester, and Merrimac series. As most of the soils are acid, alsike clover is sometimes grown in place of red clover. Red clover does well on land whose productiveness has been kept up and succeeds on new land in spite of the acidity, but on run-down fields it is not very successful.

In 1909 oats were grown on 37,838 acres, with a total production of 697,853 bushels. This crop gives best results on the fine sandy loams, loams, and silt loams. It is often grown on some of the light sandy soils, but with unsatisfactory results.

Potatoes in 1909 occupied 30,637 acres, giving a total production of 2,508,521 bushels. This crop is grown successfully throughout the sandy areas of the county, but best yields are obtained where there is sufficient clay in the soil to make it somewhat loamy. Potatoes are grown in all parts of the county and to some extent on practically all the soils.

Rye was seeded on 19,858 acres in 1909, and produced 222,333 bushels. Rye is grown most extensively on the sandy soils, and it gives better results on the extremely sandy types than any of the other small grains.

The total area in corn in 1909 was 15,834 acres, and the production amounted to 394,189 bushels.

Barley is grown to a small extent. In 1909 this crop was grown on 1,184 acres, and produced 25,652 bushels. The acreage of barley has apparently increased somewhat during the last few years.

Wheat is grown only to a very small extent, although at one time it was the most important crop in the county. Buckwheat is grown in various parts of the county, chiefly on the marshy tracts where the drainage conditions have been improved. Peas and beans are grown to a limited extent.

Some trucking is done in the vicinity of Stevens Point. On most farms small plots are devoted to cabbage, lettuce, radishes, onions, strawberries, brambleberries and other vegetables and small-fuit crops for home use. The sandy soils are probably better adapted to trucking than to any other line of farming.

The following table shows the acreage and production of the principal crops in the last four census years:

Croy	1879		1889		1899		1909	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn	12,131	278.749	14,489	403,088	17,289	388,100	15,834	394,189
Oats	9,749	225,614	24,453	739,527	32,878	734,080	37,838	697,853
Wheat	21.853	204,778	4,342	54,814	6,373	85,910	397	5,376
Rye	10,144	111,659	15,151	186,155	20,469	217,780	19,858	222,333
Barley	965	16,544	471	12,779	421	7,550	1,184	25,652
Buckwheat	723	3,819	1,607	19,086	983	9,270	496	3,850
Potatoes	....	213,570	12,094	1,324,761	29,099	1,978,344	30,637	2,508,521
Peas	....	782	....	7,560	417	6,608	319	1,799
Beans	....	1,210	....	1,451	43	379	52	480
		Tons		*Tons*		*Tons*		*Tons*
Hay	16,346	13,470	29,388	30,203	36,884	43,444	48,286	47,982

Fruit growing receives little attention in Portage County, since a large proportion of its area is not well adapted to this industry. Apples are grown more extensively than any other fruit. On many of the farms there is a small orchard which usually supplies apples for home use and in some years a surplus to sell. Apples do best over the eastern and northeastern

parts of the county, where the surface is more or less rolling. The level tracts of sandy soil are not suited to this fruit.

The raising of live stock is an important industry. The 1910 census reports 31,378 head of cattle, 9,255 horses, 13,264 hogs, and 5,075 sheep in the county. In 1909 there were 7,954 calves sold or slaughtered, 5,415 other cattle, 13,980 hogs, and 2,198 sheep. Animals sold or slaughtered in that year amounted in value to $413,564. Most of the calves and steers sold are from dairy herds. Hogs are raised in conjunction with dairying and general farming. Hog raising is not as well developed in this county as in sections where more corn is grown.

There were 18,783 dairy cows in the county in 1910, and the dairy products of the preceding year, exclusive of those used in the home, had a value of $606,348. There were 27 creameries and 3 cheese factories in the county in 1913. Milk and cream are sold at retail in the towns in a small way. Dairy cows of Holstein breeding are more numerous than those of any other breed. The use of purebred sires is gradually improving the stock.

Differences in the character of the soil in various parts of the county have some influence upon the distribution of the crops. Oats are grown more extensively on the heavier soils than on the sandy types, while potatoes are more profitable on the sandy types than many other crops. Rye is grown most extensively on the light-textured soils and gives better results on this class of land than do the other small grains. The dairy industry is most successfully developed on soils which have a texture as heavy as or heavier than a fine sandy loam.

The general methods of farming followed are about the same as those practiced throughout the general farming and dairying districts of Wisconsin. The silo is in quite common use on dairy farms, and a considerable part of the corn crop is handled as ensilage. The hay crop is mostly stored in barns or stacked and used mainly as feed for stock. In potato growing modern machinery is in common use, and where the acreage will justify their purchase most farms are supplied with horse-drawn planters, diggers, and spraying outfits. In all lines of farming modern machinery is in common use on most of the farms. The farm buildings vary greatly in quality. On the extremely sandy soils the buildings are frequently inferior and

in poor repair, while those on sandy loam and heavier soils are much better. The barns are usually equipped with large hay forks or slings for use in unloading hay. The work stock and implements are not as heavy over most of the county as in many other parts of Wisconsin, since most of the soils are sandy and easy to cultivate.

A rotation quite commonly followed on the sandy soils consists of small grain followed by clover and this by potatoes. The second crop of clover in a few cases is plowed under as a green-manure crop. On the extremely sandy types it is desirable to arrange the system so that the ground may be covered as much of the time as possible to prevent drifting, which often causes considerable damage to growing crops. In some cases so much of the soil is blown away that the seed is left exposed. On the heavier soils the usual rotation is somewhat different from that on the lighter types. Here corn more frequently takes the place of potatoes, and the land is usually left in grass for hay for two years and frequently is pastured for one year before again being plowed. On neither the sandy nor heavy types has the question of crop rotations been given careful study.

Stable manure is the fertilizer used most extensively, but the supply of this is not sufficient to meet the requirements of the soil. Commercial fertilizers are not in common use. They are used mainly on the marsh soils, especially in the vicinity of Coddington. The peat soil is deficient in potash and phosphorus and is also acid. A large tonnage of wood ashes was recently applied to peat soils near Coddington at the rate of about 1,000 pounds per acre. A considerable amount of rock phosphate is used in the county, usually at the rate of about 1,000 pounds per acre. Acid phosphate is in some instances applied by itself or along with the rock phosphate. The use of ground limestone for correcting soil acidity is coming to be recorganized as profitable, and a number of farmers both on the peot soils and on the uplands have tried liming, with success. Trials with mixed commercial fertilizers have been made in several instances, especially on potatoes, with satisfactory results.

The supply of farm labor is fairly good. In many cases women and children assist with the farm work. Where hands are hired for the year or by the month the wage usually ranges

from $25 to $50 a month, depending upon the experience of the laborer. Married men are usually given fuel and the use of a house and garden. During haying and harvest periods, when extra day help is often needed, the wage is usually $1.50 to $2 or more a day.

The average size of farms in Portage County as given by the census of 1910, is 127 acres. In the marshy areas and in the least developed parts of the county land is frequently held in large tracts. In 1910 there were 3,229 farms in the county, comprising 79.1 per cent of its total area. Each farm has on an average 68 acres of improved land. Practically 90 per cent of the farms are operated by the owners.

In 1900 the average assessed value of land in the county was $13.47 an acre. By 1910 this had increased to $27.94 an acre. Where general farming is most highly developed, on the heavier soils, land values frequently reach $100 an acre. Comparatively few farms have a higher value than this. On the extremely sandy soils many partly improved farms can be bought for $20 to $40 an acre. On reclaimed marsh land farms sell for $30 to $70 an acre, the price depending largely upon the improvements, drainage, and location. Cut-over land in the undeveloped sections may be bought for $18 to $30 an acre. Unimproved marsh land, where no effort has been made toward reclamation, is usually of lower value than any other character of land in the county.

CHAPTER VIII

CLIMATE

Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall. Any one of these factors may determine the type of farming which can be followed to best advantage.

The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the state as a whole is 31 inches.

The local distribution of rainfall varies, however, from year to year in different sections. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the entire state during the driest year was 21.4 inches, and for the wettest year 37 inches.

Of equal importance in agriculture to the total rainfall is its seasonal distribution, and in this respect Wisconsin is usually fortunate, since about half of the total rainfall comes in May, June, July and August, and nearly 70 per cent from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches, and May 3.9 inches. The average rainfall for the state during winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches, and during autumn 7.4 inches. The small winter precipitation in Wisconsin, mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil or erosion.

The climatic conditions prevailing in Portage County are somewhat variable owing to differences in topography and soil. In the southwestern part of the area there are extensive marsh areas, most of which have been reclaimed. Throughout the valley of the Wisconsin River, which traverses the western side

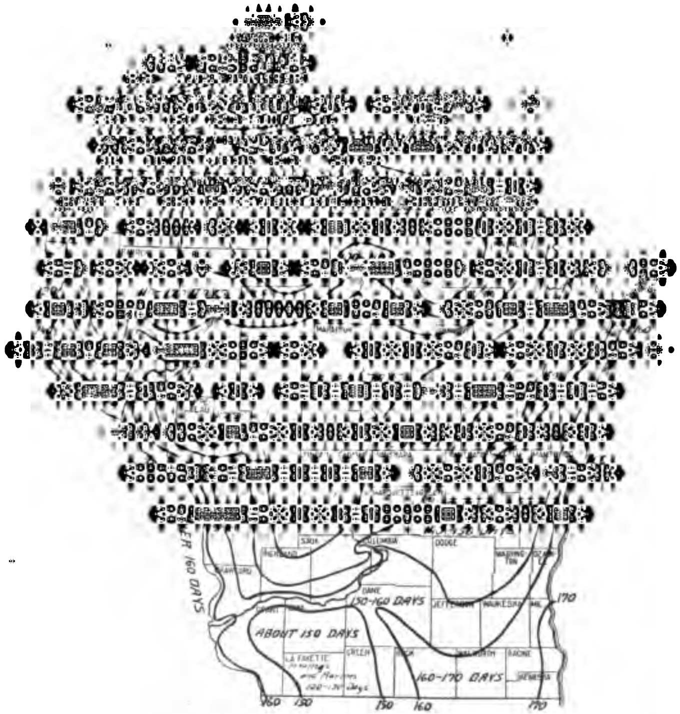

Fig. 2. Map showing length of growing season for corn.

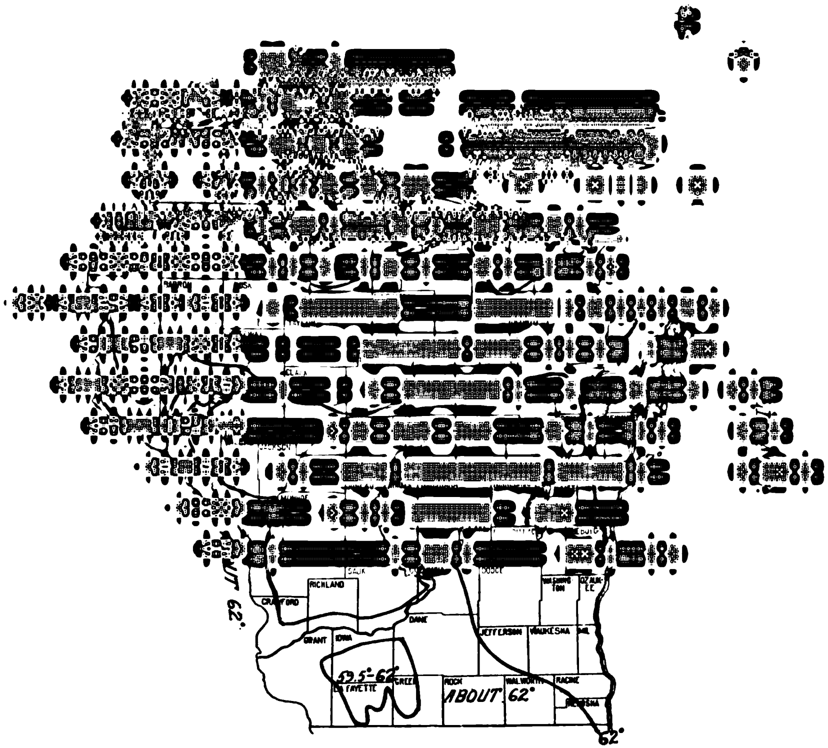

Fig. 3. Map showing average temperature for the six growing months April to September, inclusive. Note that the difference between the average temperature for the areas surveyed, and the southern portion of the State is only slight, varying from 2.5 to 5 degrees.

of the county, and also along part of the southern border, there are extensive sandy spots, with marshy tracts frequently intervening. Throughout the northeastern, east-central and extreme northwestern parts of Portage county the surface is gently rolling to rolling and danger from late spring and early fall frosts is not as great as over the lower lying sections of the area.

Two weather bureau stations of long standing are located within the area. The station at Stevens Point is near the Wisconsin River and records from this place are representative of conditions prevailing over the extensive level sandy terraces throughout the county. The station at Amherst is situated in a more rolling country and represents the upland portion of the survey. No records are available from the extensive marsh tracts, but is is probable that the marshes have a somewhat shorter growing season than the remainder of the county.

The following table gives the Normal, Monthly, Seasonal and Annual Temperature and Precipitation as Recorded at Two Stations Within the County.

Month	Stevens Point (Elevation 1.113 ft.		Amherst (Elevation 1,290 ft.)	
	Temperature F°	Precipitation inches	Temperature V°	Precipitation inches
December	19.0	1.26	19.4	0.63
January	14.8	1.04	14.1	1.27
February	13.9	0.85	14.3	1.28
Winter	15.9	3.05	15.9	3.98
March	29.4	1.39	27.9	1.78
April	44.6	1.52	43.8	2.61
May	56.2	4.00	55.1	4.07
Spring	43.1	8.09	42.2	8.46
June	65.5	4.17	64.9	4.29
July	69.6	3.40	69.6	3.63
August	67.5	2.89	67.3	3.22
Summer	67.5	10.46	66.9	11.18
September	60.4	3.34	6.00	3.25
October	47.9	2.53	47.7	2.60
November	32.7	1.73	31.7	1.70
Fall	47.0	7.59	46.5	7.55
Year	43.4	29.10	43.0	31.37

DATA OF LAST AND FIRST KILLING FROSTS.

Station	Length of Record Yrs.	Average date of		Average length of growing season.
		Last killing frost in spring	First killing frost in fall	
Stevens Point.	7	May 25	Sept. 26	123
Amherst	18	May 22	Sept. 27	127

It will be observed from these tables that Stevens Point has a mean annual precipitation of 29.1 inches, and Amherst 31.37 inches. It will also be observed that a large proportion of the rainfall comes during the growing months when most needed. For the six months from April to September inclusive there is an average monthly rainfall of over 2½ inches. Although the rainfall is normally well distributed there are frequently dry spells, especially during July and August, during which crops suffer from lack of moisture.

The winters in this region are long and severe with a snowfall of 41 inches, but the summers are pleasant and farm crops make rapid growth. Storms of a destructive nature are very rare in this region. There is an abundant supply of excellent water, which is readily obtainable for both man and beast. The climate is healthful and well suitable to a very high development of agriculture.

SUMMARY

Portage County is situated in the central part of the State of Wisconsin. It comprises 812 square miles, or 519,680 acres. The surface features vary from level to rolling and hilly. The average elevation of the county above sea level is about 1,110 feet.

The eastern third of the county drains toward the east through tributaries of the Little Wolf and Waupaca Rivers into Lake Michigan, while the remainder of its area drains into the Wisconsin River, and thence into the Mississippi.

Portage County was organized in 1844. The early settlers came largely from eastern States. The total population in 1910 was 30,495. The population is 71.9 per cent rural. Stevens Point, the county seat, with 8,692 inhabitants, is the only place with a population larger than 1,000. Portage County has good railroad connection with many large cities and markets.

The soil material of Portage County has been derived from glacial, residual, and alluvial materials. The soils have been classified into 14 soil series and 24 soil types, each of which has characteristics by which it can be recognized.

The agriculture of the county shows all stages of development. The best farming land is in the northwestern, northeastern, and eastern parts of the county, where fine sandy loam or heavier soils predominate. Soils of lower value, mostly sandy or marshy, occur throughout the central, southern, and north-central sections.

The principal crops are hay, oats, potatoes, rye, corn, barley, and buckwheat. General farming is the prevailing type of agriculture, and dairying and potato growing are two of the most important interests.

Over 79 per cent of the total area of the county is in farms. The average size of the farms is 127 acres, of which on an average 68 acres are improved. About 90 per cent of the farms are operated by owners.

The mean annual precipitation for the county is about 30 inches, and the mean annual temperature is about 43° F. The

winters are long and severe, with a snowfall of about 41 inches, but the summers are warm and crops make rapid growth. There is a growing season of about 125 days free from killing frosts.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

W. O. HOTCHKISS,
Director and State Geologist

A. R. WHITSON,
In Charge, Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean.

BULLETIN NO. 52-D **SOIL SERIES NO. 19**

SOIL SURVEY

OF

DOOR COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, AND H. V. GEIB

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

CARL THOMPSON

of the United States Department of Agriculture, Bureau of Soils.

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS,
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

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* Scientist in Soil Survey, In charge of field operations in Wisconsin for the Bureau Soils, U. S. Department of Agriculture.

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INTRODUCTION

Before the greatest success in agriculture can be reached it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their

physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles.. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere.

Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of

these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.

Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.

Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20—50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.

Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Sandy clay.—Less than 20% silt.

Soils Containing Between 20–50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.

Silt loam.—Less than 20% clay, and over 50% silt.

Clay loam.—Between 20 and 30% clay, and less than 50% silt.

Silty clay loam.—Between 20 and 30% clay, and over 50% silt.

Clay.—Over 30% clay.

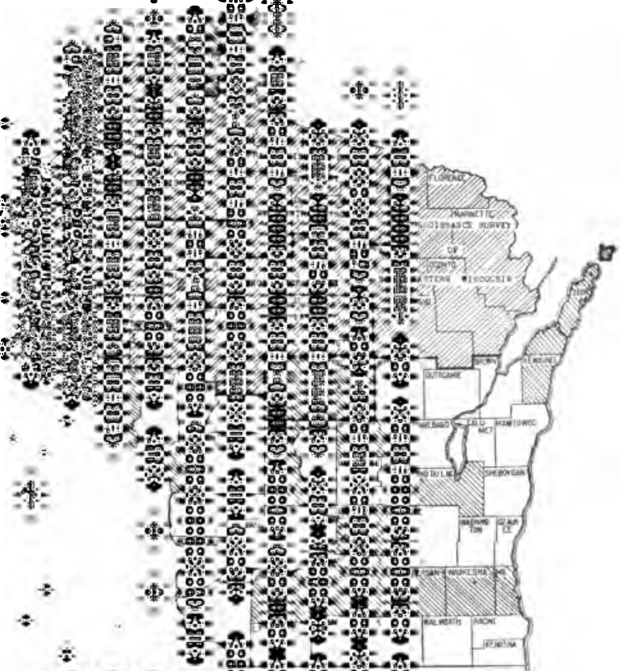
Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for examples, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in

regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

R COUNTY,

THE AREA.

n part of Wisconsin, rates Green Bay from nd, which forms part



Surveyed.

and by Porte des Morts west point. County on the south. in fact, since the com-

pletion of the Sturgeon Bay ship canal the northern end of the peninsula is really an island. The peninsula is 18 miles wide at the base and gradually tapers to a width of about 4 miles. Its shores are very irregular, being indented by numerous bays and harbors. There are over 200 miles of shore line in the county. The distance from the extreme southwest corner of the county to Gills Rock, at the northern point of the peninsula, is nearly 60 miles. From Gills Rock to the northernmost point of Washington Island is 10 miles. The county comprises a total area of 469 square miles, or 300,160 acres.

The most prominent topographic feature in the county is the long line of rugged bluffs bordering Green Bay, extending almost unbroken from a short distance north of Sturgeon Bay to the northeast point of the peninsula. In some places the bluffs reach the water's edge; elsewhere they may be some distance back from the shore. Government Bluffs, on Sturgeon Bay in Nasewaupee Township; Eagle Bluff, at Ephraim; and the bluffs at Fish Creek and Ellison Bay are the highest and most striking in the county. They rise to elevations of 20 to 200 feet above the lake. From the top of these bluffs there is a gradual slope toward the eastern side of the peninsula, where a low narrow strip of Beach sand, or in places beach gravel, occurs. Just back of this beach are extensive areas of Peat. In the town of Claybanks high bluffs occur less than one-fourth mile back from the lake shore, in contrast to the conditions existing to the north of the Sturgeon Bay ship canal. The topography of the county in general is undulating to gently rolling, very little of the land being too rough for ordinary agricultural use. Some nearly level areas occur, principally in the swamps. Limestone escarpments and rock outcrops are quite abundant in that part of the county north of Sturgeon Bay. The surface here is typical of a glaciated region, with swamps and depressions scattered throughout the rolling upland. The southern part of the county is less rolling than that portion north of Sturgeon Bay, and marshes are smaller and more numerous than farther north, where most of the Peat occurs in a few large areas. A few small terraces occur on both shores of the peninsula. The topography of Washington Island is similar to that of the northern part of the county, varying from undulating to gently rolling. Chambers Island in Green Bay is nearly level, and is practically

free from stone and rock. The elevation of the mainland of the county probably averages 100 to 150 feet above Lake Michigan, which lies 580 feet above sea level.

Door County has no large streams within its borders. The largest is the Ahnapee River, which flows south through Forestville and enters Lake Michigan at Algoma in Kewaunee County. That part of the county north of Sturgeon Bay has a few short streams, some of which are dry during a large part of the year. The southern part of the county is quite well traversed by small streams, some flowing into Green Bay and some into Lake Michigan, but owing to the heavy nature of the soil and subsoil drainage is in many places deficient.

Door County was formally opened for settlement in 1831. In 1835 the first white settler located on what is now called Little Sturgeon Point. The county was organized in 1851. In 1852 a colony of Moravians settled at Ephraim, in the northern end of the peninsula. In 1853 a colony of Belgians took up settlement at Brussels, in the southern part of the county. A settlement was very early made on Washington Island. In the northern end of the county, especially in the neighborhood of Ephraim, Baileys Harbor, and Ellison Bay, the population consists largely of Scandinavians. Quite a number of Germans and Poles live in the county. Other nationalities are also represented, some of the settlers coming from neighboring counties and some from other States. In 1910 the population of Door County was 18,711, all but 4,262 of which was classed as rural.

Sturgeon Bay, the county seat, with a population in 1910 of 4,262, is the largest town. It is surrounded by an excellent farming community. Sturgeon Bay is the center of a large cherry growing section and a distrubuting center for the greater part of the county. Egg Harbor, Fish Creek, Ephraim, Sister Bay, Ellison Bay, Baileys Harbor, and Jacksonport are small coast towns north of Sturgeon Bay. Some of these towns, notably Fish Creek, Ephriam, and Sister Bay, are noted summer resorts, attracting thousands of tourists every year. The agreeable climate, the large bodies of water, the excellent roads, and the fine scenery combine to make Door County one of the most famous summer resorts in this section of the United States. Peninsula Park, the largest of the State parks, includes the

whole peninsula between the villages of Fish Creek and Ephraim and covers about 6 square miles. Fishing is an important industry in the towns and bays along the coast. Many people depend on fishing for a livelihood, and at numerous points it is engaged in on a very large scale during the entire year. Washington Island is noted for its fisheries and summer resorts.

The Ahnapee & Western Railroad, which runs from Green Bay to Sturgeon Bay, is the only railway in the county. Two automobile stage lines carrying freight and passengers, one from Sturgeon Bay to Ellison Bay on the west side of the peninsula, and the other from Sturgeon Bay to Baileys Harbor on the east side, make daily trips in both directions. Lake steamers make regular stops at Sturgeon Bay, Egg Harbor, Fish Creek, Ephraim, and Washington Harbor during the summer season and at less frequent intervals during the spring and fall, giving direct communication with Milwaukee, Chicago, and other lake parts.

The main roads of Door County are as good as any in the State. On both sides of the peninsula there are excellent macadamized roads, one from Sturgeon Bay to Ellison Bay and the other from Sturgeon Bay to Baileys Harbor. In 1916 there were 125 miles of macadamized road in Door County, and the mileage has been extended since then. The abundance of limestone makes possible the construction of good roads at a comparatively low cost. In the heavy red clay section in the southern part of the county the roads which have not been macadamized are usually difficult to travel during rainy seasons and in the spring and late fall.

Rural mail-delivery routes reach practically every farm in the county. The stage from Sturgeon Bay brings mail to post offices in the northern part of the county, and from these stations rural routes reach all sections. Mail is delivered daily to Washington Island from Ellison Bay.

Sturgeon Bay furnishes a market for considerable farm produce and provides a shipping point for fruit and other products. More fruit is shipped from Sturgeon Bay than from any other city in Wisconsin. Much of the farm produce is shipped by water.

SOILS.

Door County, in common with all northern and eastern Wisconsin, owes the general character of its surface materials to glaciation. Three more or less distinct periods of glaciation have existed, but the Late Wisconsin drift is the surface formation over practically all the county. The bedrock, which is frequently exposed, is the Niagara limestone. The soils are all derived from glacial or lacustrine material, or both. In the southern part of the county lake-laid material has been deposited, probably during interglacial times. Its most characteristic feature is the occurrence of heavy red clay in the subsoil and frequently in the surface soil. Since its deposition this material has been more or less modified by the moving ice sheet, which changed the topography from nearly level to rolling and very materially altered the texture of the surface soil.

The underlying limestone has entered largely into the formation of the glacial surface covering, but the occurrence of granitic bowlders and other rocks foreign to the region indicates that the soil material has come in part at least from distant areas. While the entire county was undoubtedly covered by ice during the Late Wisconsin glaciation, some of the soil has strong indications of being of residual origin. This is true of the shallow soils of the Miami series. It is probable that the glacier in passing scraped all the soil from some of the highest land, and after receding left areas of bare rock exposed. Since then various agencies have changed the exposed rock to soil, giving rise to some of the shallow soil occurring in different parts of the peninsula.

Since the glacial period, numerous changes in the surface material have taken place. Stream action, weathering, accumulation of organic matter, and other processes have been important factors in changing soils to their present condition. Soils of 6 separate series with 4 miscellaneous types, have been mapped in Door County. The Miami series includes the light-colored timbered upland soils derived from glaciated limestone material. The soils of glacial-lake origin are classed in the Superior, Poygan, and Clyde series, and those occupying outwash plains or terraces in the Fox and Plainfield series.

The Miami is the most extensive series in Door County. The Miami soils are light brown to brown, with a lighter colored subsoil which grows somewhat heavier with increased depth. As a rule these soils are quite shallow and stony, and contain numerous outcrops of the underlying limestone. They are derived from the weathering of glacial material of a generally calcareous nature. The topography is undulating to rolling, and the natural drainage is excellent.

The Superior series is developed in Wisconsin in the region bordering Lake Michigan and Lake Superior and in the Lake Winnebago region. It is characterized by grayish to reddish-brown or red surface soils, underlain by red or pinkish-red, heavy clay subsoils. The soil material was laid down originally as glacial-lake deposits, but it has been plowed up by subsequent glaciation and mixed with varying quantities of gravel and stony material. The topography varies from level or gently rolling to rolling, and the natural surface drainage is usually good, though the under drainage is often deficient. Where soils of this series are rolling and naturally well drained this phase has been separated from the level portions and indicated on the soil maps by a distinct color.

The surface soils of the Poygan series are dark brown to black. The subsoil is a heavy red clay, similar to that of the Superior soils. The series is closely associated with the Superior and has the same origin, except that it occupies low, wet depressions in which the decay of a luxuriant growth of vegetation has resulted in a black color of the surface soil.

The soils of the Clyde series are dark brown to black, overlying gray, brown or yellowish subsoils. The Clyde soils have been formed in lakes, ponds, or other low, swampy areas along streams or on the borders of swamps, and are confined to glaciated limestone regions. Through the influence of poor drainage and the accumulation of decayed vegetation the surface soils are black and very high in organic matter.

The Fox series consists of light-brown to brown surface soils and yellowish-brown subsoils. In topography, location, and origin the series is similar to the Plainfield, but it differs in being derived largely from limestone material. It occurs on outwash plains, in filled-in valleys, or on terraces along streams or lake shores. Occurring in a limestone region and containing

considerable limestone these soils are ordinarily not acid, or only slightly so. Soils lighter than fine sandy loam seldom occur in this series.

The Plainfield series includes light-brown soils with yellow subsoils. The material has been derived largely from sandstone and deposited on stream or lake terraces, in filled-in valleys, or as glacial outwash. The surface is level or gently undulating, and the subsoil is stratified. The series is confined chiefly to noncalcareous glaciated regions, but is encountered also in unglaciated sections of the United States in filled-in valleys and on stream terraces, and also in limestone regions where through excessive leaching all the lime carbonate has been removed and the soil is acid. The lighter types predominate in this series, and the soils tend to leachy and droughty.

Peat includes low, wet areas of partially decomposed plant remains, containing varying amounts of mineral matter. Muck includes low, wet soils high in organic matter, intermediate between Peat and the soils of the Clyde series.

Beach sand consists of material which has been washed up on the shore by the waves. Much of it, especially the areas of fine sand, has been blown by the wind to such an extend as to produce a broken surface.

Rough stony land includes steep, rocky slopes, extensive rock outcrops, extremely stony areas, and land otherwise unfit for cultivation, and valuable only for the small amount of timber and grazing it supplies.

In the following pages of this report the various soils of Door County are described in detail and discussed in their relation to agriculture. The distribution of the soils is shown on the accompanying map, and the table following gives the name and the actual and relative extent of each type.

Areas of Different Soils.

Soil.	Acres.	Per cent.
Miami loam	94,720	31.5
Superior loam, rolling phase	53,760	17.9
Peat	41,408	13.8
Miami fine sandy loam	30,528	10.2
Superior clay loam	3,008	1.0
Rolling phase	17,600	5.9
Beach sand	8,192	2.7
Miami silt loam	7,680	2.6
Miami gravelly loam	7,616	2.5
Miami gravelly sandy loam	6,780	2.3
Clyde loam	6,208	2.1
Rough stony land	5,696	1.8
Coloma fine sand	4,800	1.6
Poygan loam	3,584	1.2
Plainfield sand	1,894	.7
Muck	1,792	.6
Clyde silt loam	1,536	.5
Superior fine sand loam, rolling phase	1,344	.4
Plainfield fine sand	1,152	.4
Fox silt loam	768	.3
Total	300,160	....

CHAPTER II.

GROUP OF HEAVY SOILS.

MIAMI SILT LOAM.

Extent and distribution.—There are 7,680 acres of Miami silt loam in Door County. It occurs largely in the town of Sevastopol. Small areas are scattered over the northern part of the county.

Description.—The surface soil of the Miami silt loam consists of a brown mellow silt loam extending to an average depth of 8 inches. The content of fine sand is quite high, and when dry the soil has a loamy appearance. The subsoil is a light-brown or grayish silt loam, usually quite compact and sticky, in the lower depths. The heavy subsoil is characteristic of this type. Most of the type is more than 3 feet deep. Directly above the bedrock there is a heavy, reddish layer which contains numerous small fragments of limestone. There are usually a few limestone pebbles in the subsoil, and in places stones occur on the surface.

This soil is quite uniform. The most important variation is in the depth to bedrock, which varies from 1 to more than 3 feet. In very few places is the bedrock within 1 foot of the surface. Some rock outcrops occur, but the type is not as stony as the Miami loam and fine sandy loam.

Topography and drainage.—The surface varies, as in Miami loam, from gently undulating to rolling. This type is not as rolling and in some places, as in sec. 21 and the NW.¼ of sec. 22, T. 28 N., R. 26 E., and in the immediate vicinity of the Institute, there are some nearly level areas. In the rolling sections the surface drainage is excellent, but in the more level areas where a heavy subsoil occurs the underdrainage, and even the surface drainage, is quite commonly deficient.

Origin.—The Miami silt loam is derived from glacial débris laid down mostly in the form of a ground moraine. The surface soil, which is quite silty, may have been deposited in part by winds. The gravel and stones are largely limestone, and it is probable that limestone from the bedrock has entered largely into the formation of the type. The subsoil does not show an acid reaction, but the surface material has been leached to such an extent that a slightly acid condition has developed in places.

Native vegetation.—The original forest growth on this type consisted of maple, basswood, elm, balsam, birch, white pine, and different varieties of oak. All the valuable timber has been removed, and approximately 60 per cent of the type is now under cultivation. Part of it is still uncleared and used as woodlots or for permanent pasture

Present agricultural development.—This is a very valuable type agriculturally. The chief line of farming carried on is dairying. All the common farm crops are grown and produce good yields. Corn, small grains, and grasses are well adapted to this soil. Some cherries and apples are grown, and good results are obtained where the surface is sufficiently rolling and the subsoil is not so heavy as to prevent good drainage. Some cherry orchards set out on level areas with the heavy subsoil have made poor growth or died.

This type is somewhat harder to work than the other Miami soils and requires more thorough cultivation to maintain a proper physical condition. On account of its heavy subsoil, it remains wet until late in the spring. Stable manure is the only fertilizer used, and where cherries are grown the greater part of this is applied to the orchard. The rotation commonly followed consists of corn, a small grain for 2 years, and timothy or clover. This soil seems best suited to dairying and the growing of general farm crops. * *

SUPERIOR CLAY LOAM.

Extent and distribution.—The Superior clay loam with its rolling phase occupies a toal of 20,608 acres, of this total amount 3,008 acres are classed as the typical soil having a level surface, and 17,600 acres is classed as the rolling phase

* * For a discussion of the chemical composition of this soil, and methods for its improvement see page 25.

because of its more uneven surface features. The level phase is found most extensively in the Town of Brussels, although there are a number of small tracts scattered throughout the southern portion of the county. There is none of this soil north of Sturgeon Bay.

Description.—The typical Superior clay loam to a depth of 6 or 8 inches consists of a dark-brown to reddish-brown clay loam. In places the surface soil is gray. The subsoil is a heavy, compact, red clay, extending to depths below 3 feet. Occasionally a little gravel occurs on the surface, and there is usually some gravel in the subsoil. Very few stones occur in this type.

Some variations occur in color and texture. In the area just south of Brussels and in section 25 of Union Town the surface soil is darker than typical, but not dark enough to be typical of the Poygan soils. Near the edges of marshes and bordering soils of the Poygan or Clyde series the surface soil is usually dark colored. In some places the surface soil is more nearly a loam than a clay loam. The red clay is seldom exposed at the surface.

Topography and drainage.—Owing to the level to vary gently undulating surface and heavy texture, the drainage of this soil is very deficient. In many places, especially in depressions, water stands until late in the spring and after heavy rains at other seasons of the year.

Origin.—This soil has been derived largely from lacustrine material, but has been modified somewhat since its first deposition by the action of ice. The original level surface was only slightly changed by the passing glacier, and little gravel and but few stones were mixed with the soil.

Native vegetation.—The original timber consisted of maple, elm, oak, ash, hickory, some beech, and in places pine.

Present agricultural development.—A considerable portion of this type is under cultivation. Part of it still supports the original forest, and some areas are covered with a second growth of poplar. The chief crops grown are oats, barley, rye, corn, clover, and timothy. In wet seasons crops often produce very poor yields. In ordinary years the yields are good. The yield of hay is especially good.

The Superior clay loam is a difficult soil to handle, and requires very thorough tillage to maintain a satisfactory seed be. When plowed too wet it is apt to puddle, and in the heavier areas large clods are frequently turned up. The type, especially in the low, wet spots remains wet and soggy until late in the spring. Stable manure is the only fertilizer used.

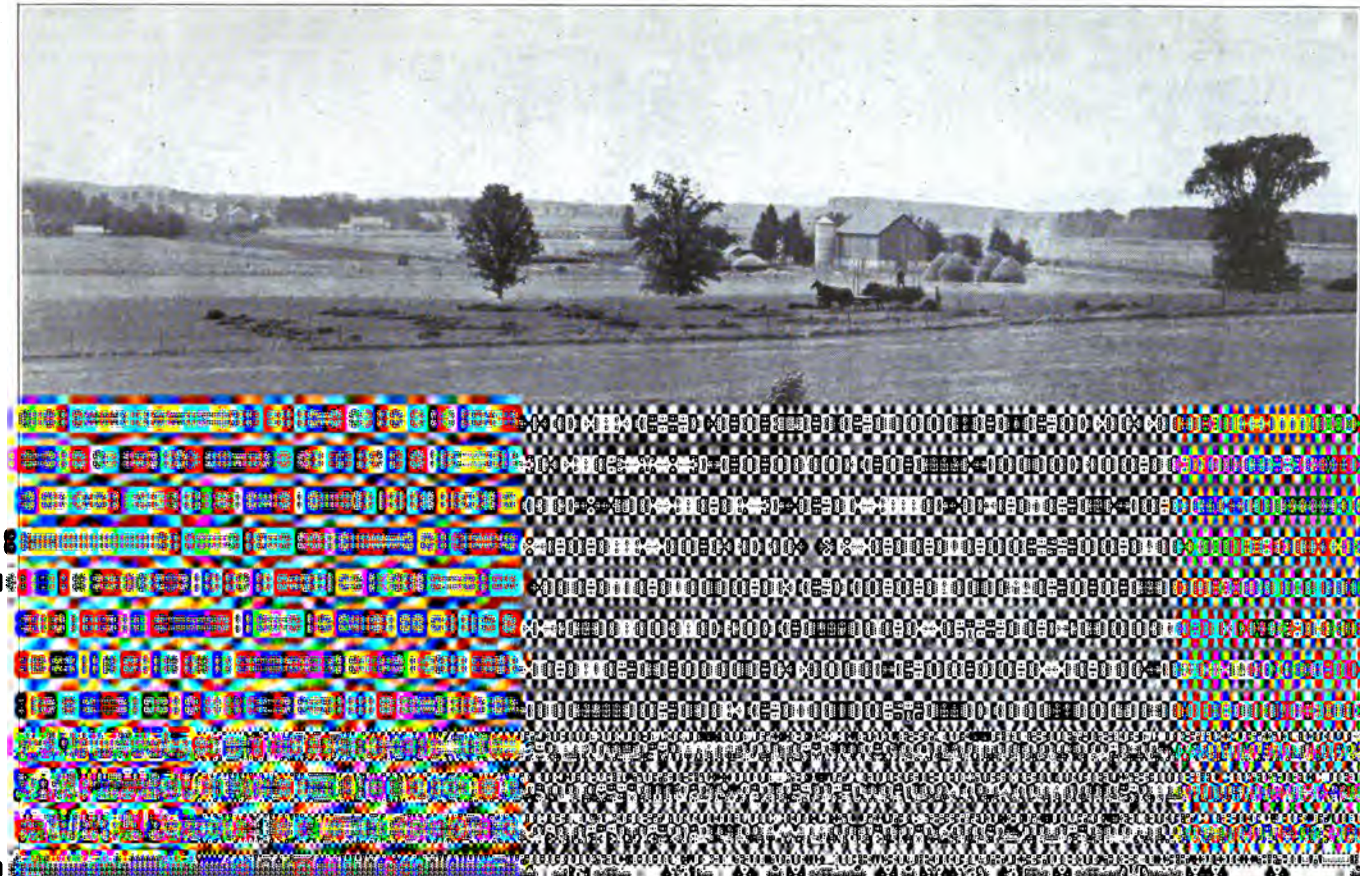
SUPERIOR CLAY LOAM

(ROLLING PHASE)

Extent and distribution.—Next to the Superior loam, rolling phase, this is the most extensive and important soil in the southern part of the county. The most extensive tracts are found in the Town of Brussels, with a number of smaller tracts in the Town of Garden, and other scattering patches throughout the region south of Sturgeon Bay. This soil is associated chiefly with other types of the Superior series, and it also borders Miami soils in a few instances.

Description.—The rolling phase of Superior clay loam to an average depth of 8 inches consists of a reddish-brown clay loam which contains a high percentage of silt and is low in organic matter. Gravel, stones and bowlders are scattered over the surface in places. The subsoil consists of a heavy, compact, red clay loam, which extends to the underlying limestone rock. In the subsoil, especially just above the bedrock, angular gravel, bowlders, and small fragments of limestone are encountered, but the gravel is not as abundant as in the loam. A small percentage of the gravel and bowlders is of rocks foreign to the region, such as granite, quartz and gneiss.

The depth and color of the surface soil vary somewhat. In depressions and on gentle slopes the soil is deeper and darker than typical, while on hills and knolls the red clay is frequently exposed. The depth to bedrock also varies. In some places the depth is less than 3 feet and elsewhere it may be 15 feet or more. In sections 4, 5, 8, 17, and 24, of Gardner Town, and on the plateau-like formation in sections 21, 22, 28, and 29, Brussels Town, the depth to the underlying rock is less than typical, being in many places less than 3 feet. A number of outcrops also occur in these sections. In sections 22, 23, and 26, in the town of Brussels, the surface is less rolling than typical, but



the soil is hardly sufficiently level to be included with the Superior soil.

Topography and drainage.—The surface varies from undulating to gently rolling, and in a few places to very rolling. The area surrounded by the rock escarpment in sections 20, 21, 28, and 29, Brussels Town, is elevated considerably above the surrounding country and presents a plateau like appearance. The surface here is more nearly level than is typical. The type is more poorly drained than the Kewaunee loam and tile drains can profitably be installed especially where the surface is nearly level or where depressions occur.

Origin.—The soil was originally laid down in a lake bed and later reworked by the glaciers. Some of the underlying Niagara limestone was broken up and mixed with the soil, and the surface features changed from level to undulating or rolling. The lime content increases with depth. In some places leaching has left the surface material in an acid condition.

Native Vegetation.—The native forest growth consisted chiefly of maple, beech, oak, hickory, elm, ash, with some hemlock and pine.

Present agricultural development.—This soil is naturally very productive and the greater part of the type is under cultivation. The chief crops grown are oats, wheat, rye, barley, corn, potatoes, clover, and timothy. Excellent yields of hay are obtained and the other crops produce well. New varieties of corn mature, but corn does not always ripen. It can always be depended upon, however, to reach the stage where it makes good silage. Dairying is the most important line of farming followed. The soil is ideal for growing hay and for maintaining good pasture.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Superior clay loam, rolling phase.

Mechanical analyses of Superior clay loam, rolling phase.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Soil	0.5	3.3	4.4	20.0	11.4	35.3	25.2
Subsoil	1.0	3.5	4.7	19.9	14.0	29.5	27.4

FOX SILT LOAM.

There are only 768 acres of this kind of land in Door County, and it is the least extensive of any of the soils. Small patches occur near Sturgeon Bay and elsewhere in the northern part of the peninsula. It is confined to the region of Miami soils.

The Fox silt loam to an average depth of 8 inches consists of a grayish to dark-brown, friable silt loam, which has a smooth feel when moist and assumes an ashen-gray appearance when dry and pulverized. The subsoil consists of a gray or yellowish-brown loam or fine sandy loam. The deep subsoil is often stickly and sometimes consists of a light-colored marl-like material. The limestone bedrock usually is encountered within 3 or 4 feet of the surface. The soil is usually neutral or calcareous.

The surface is level to very gently undulating and the natural drainage is frequently somewhat deficient.

The Fox silt loam occurs on outwash plains, in filled-in valleys, or on lake or stream terraces, and consists of material deposited by water chiefly by streams issuing from the glacier. The soil has been formed from glacial débris ground mainly from the limestone underlying this part of the State.

The original forest growth on this soil consisted chiefly of elm, ash, birch, and maple, with willow in the lower situations. Some areas are under cultivation, and where drainage conditions are favorable the yields average about the same as on the Miami silt loam and loam. Corn, oats, barley, and hay do well. This soil usually forms parts of fields in which the Miami loam is the predominating type, and the methods of cultivation, crop rotation, and fertilization are practically the same as on the latter soil.

Some small areas of a fine sandy loam are included with the Fox silt loam. This coarser soil consists of an average of 8 inches of friable, dark-brown fine sandy loam, with a sub-soil of light-colored fine sandy loam which becomes lighter in texture with depth. The deep subsoil is usually a pale-yellow very fine sand. In some places a sticky layer of sandy clay may occur at about 2 feet, but this layer is usually underlain by sand. This coarser soil occupies a total area of less than 1 square mile.

The largest area occurs on Washington Island, in the vicinity

of Detroit Harbor. A few small patches occur in other parts of the county, all north of Sturgeon Bay. The surface is level, but drainage is fairly good on account of the sandy subsoil. The soil is derived from the weathering of glacial outwash material, and contains considerable limestone gravel. It differs from the Plainfield soils in that it has been derived largely from limestone, while the Plainfield soils have been derived largely from sandstone. A considerable part of this fine sandy loam soil is under cultivation. It produces good yields of the common crops. It can be easily worked into good tilth.

CHEMICAL COMPOSITION AND IMPROVEMENT OF HEAVY SOILS.

In chemical composition these types of soil are quite similar. They all contain approximately 1200 pounds of phosphorous in the surface 8 inches per acre.

The total amount of potassium is large in all of these types, varying from apporximately 44,000 to 55,000 pounds in the surface 8 inches of an acre. The problem of the potassium supply for crops on these soils is chiefly that of having sufficient organic matter to produce the necessary chemical changes in the inert potassium compounds of the soil to render them available to plants. The total amount of organic matter is approximately 3 per cent, or 60,000 pounds per acre. This is relatively small and should be increased by every practical method. The total nitrogen content is also relatively small and should be increased by the growth of legumes in all rotations.

The amount of lime or lime carbonate contained in these soils is extremely variable. As a rule, fields which have been cropped for a number of years have lost nearly or quite all the lime originally contained in the surface soil, and have in some cases become acid. The subsoil, however, often still contains very large amounts of this material, sometimes running as high as 20 per cent, but for the insurance of good growths of plants requiring lime, especially alfalfa, this will have to be supplied in all cases where the surface shows a distinct acid reaction.

* The "Truog Test" for determining soil acidity is a new method which has just been perfected by E. Truog of the Soils Department of the University of Wisconsin, by which the relative degree of acidity can be accurately determined in the field or laboratory in a few minutes time. For a detailed description of this method write the Soils Department, College of Agriculture, Madison, Wis.

In the improvement of this group of soils the factor which may well be given first consideration is a means of increasing the amount of organic matter and the supply of nitrogen. As the supply of stable manure is usually inadequate, it should be supplemented by green manuring crops of which the legumes are the best. Plowing under a second crop of clover once during each rotation will greatly assist in increasing the productivity of the soil. This will not only increase the supply of nitrogen in the soil but it will also improve the physical structure, which is highly desirable, especially in the case of the Superior clay loam. The presence of a large amount of organic matter will also assist in making available for the plant a larger amount of potassium.

As indicated by various field experiments, the Superior clay loam,* responds very well to the application of phosphate fertilizers supplementing the stable manure.

By using ground rock phosphate to supplement manure the yield of clover hay was increased 43 per cent over plots which received only stable manure. Likewise the yield of potatoes was increased 47 per cent by the use of ground rock phosphate. The rock phosphate may be applied at the rate of about 600 pounds per acre, once during each crop rotation. As the phosphorus in this form is only slowly available there will be but little, if any, loss if larger applications are made.

Similar results may be expected on the Miami and Fox silt loams, with rock phosphate. The element phosphate may also be supplied in the form of acid phosphate and as such becomes available immediately to the plants. Application should be from 200 to 300 pounds per acre, and may be made to small grain or corn at the time of planting.

Whenever an acid condition is found to exist on any of these soils this should be corrected by the application of ground limestone. About two tons per acre will be required, but the exact amount will depend upon the degree of acidity. The limestone may be applied at any convenient time as it is slowly soluble and will remain in the soil for a number of years. It should be applied evenly to the surface of a plowed field and harrowed or disked in so as to be thoroughly mixed with the soil. It should not be plowed under.

* For more information on heavy clay soils consult Bulletin 202, Wisconsin Experiment Station on "How to Improve Our Heavy Clay Soils"

The question of drainage* is a very important one, especially on the typical Superior clay loam where the surface is level and where the water moves off slowly. Practically all of this soil would be greatly benefited by tile drains, and while their use is not essential to the production of profitable yields, it is known that when properly placed they will pay for themselves in the course of a few years. As land values in this section are high it is important that every portion of the farm should produce maximum yields, but such yields cannot be secured unless the soil is well drained. Because of wet conditions which often pevail in the spring, planting is frequently delayed and it is not uncommon to see numerous low spots in a field which produce nothing. There are a number of places on the rolling phase of the Superior clay loam, and on the Miami silt loam which would also be benefited by tile drains. Open ditches may frequently be used to advantage to supplement the tile drains, but they should not be depended upon entirely. Where the surface is level the land may be plowed in narrow strips leaving dead furrows from 2 to 4 rods apart. When these are kept clean the surface water will flow through them into open ditches along the side of the field. This system has given very good results when used by itself, but the drainage of the land is much more complete, and better results are obtained when such surface drains are used to supplement a system of tile drains.

Another factor which is very important in the improving of heavy soils is cultivation. The Superior clay loam is more difficult to handle than the silt loam types in this group, and great care should be exercised in all cultural operations. All working of heavy clay soils should be done only when dry enough not to puddle. Plowing when too wet will have a bad effect in 3 or 4 years. Before a crop is planted the soil should be thoroughly pulverized and the seed bed in a loose, mellow condition. All after cultivation of intertilled crops should be sufficiently frequent to maintain a good surface mulch, to conserve the moisture and to permit a free circulation of air through the soil.

The silt loam types may be worked under a considerably wider range of moisture conditions than the clay loam, and

* See Wisconsin Bulletins 229 and 284.

fields can be kept in good physical condition with a smaller amount of labor, but the necessity of thorough cultivation on all of the soils should not be overlooked.

On the Superior clay loam a 4 or 5 year rotation seems to give the best results. The first crop may be small grain, such as rye, oats, barley or wheat, seeded down to clover, with a little timothy mixed in it. The second year the clover will be grown, the first cutting for hay and the second left to grow for seed. The third year, crops of mixed clover and timothy will be harvested. Manure may be spread on the sod either before plowing in the fall or on the plowed land in the winter. The fourth year the land should be put into cultivated crops. In this scheme of crop rotation, one-fourth of the land is in grain, one-fourth in clover, one-fourth in mixed clover and timothy and one-fourth in cultivated crops. This same system may well be followed on the silt loam types, but minor modifications may be necessary to fit the conditions of individual farms.

While the dairy industry is highly developed on these soils it could be profitably extended to still greater proportions. Alfalfa has proven to be a successful crop, and it should be grown on every dairy farm. Sugar beets, mangels, rutabagas and turnips do well and may often be added to the list of profitable crops. When green manuring is to be practiced the second crop of clover may be plowed under and followed by corn, and two small grain crops grown in the rotation in place of one.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS.

MIAMI LOAM.

Extent and distribution.—Miami loam is the most extensive and important type of soil in Door County. It covers a total of 94,720 acres or 31.5 per cent of the county. It is the predominating soil throughout the country north from Sturgeon Bay, occurring in association with other types of the Miami series.

Description.—The surface 6 to 8 inches of the Miami loam consists of a yellowish-brown to grayish-brown loam. The subsoil consists of a yellowish-brown loam or fine sandy loam grading into a thin layer of compact, reddish loam which contains fragments of partially decomposed limestone. This heavy layer rests upon the bedrock, which typically occurs within 3 feet of the surface. The type grades into a fine sandy loam on one hand and into a silt loam on the other, but so gradually that a sharp boundary cannot always be drawn. As this was originally a forest region the soil is somewhat deficient in organic matter. In virgin areas there are numerous bowlders and fragments of limestone. The stoniness is quite a serious handicap in farming especially in the northern end of the peninsula where the soil is particularly shallow and bowlders numerous. In some small areas where the soil is extremely shallow angular limestone gravel occurs. These areas are indicated on the map by symbol.

The type is quite uniform in texture, although it does include small areas in which the surface soil is either too light or too heavy to be typical, and others in which the subsoil is too heavy to be typical. The most important variation is in the depth to the underlying rock, which varies from 1 to 3 feet. Areas in which the soil is less than 1 foot deep, as well as those in which it is more than 3 feet deep, are indicated on the map by symbol. The typical Miami loam has a depth of soil of 1 to 3 feet.

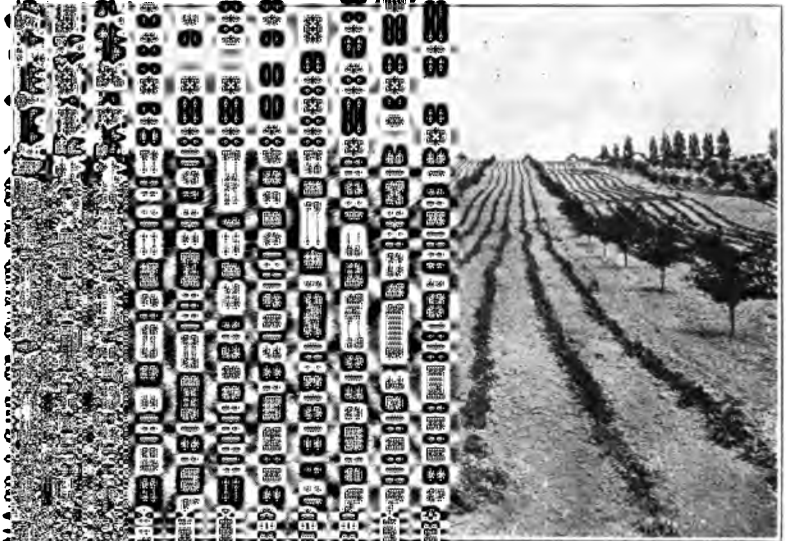
Topography and drainage.—The topography is undulating to gently rolling. In some sections large plateaulike elevations rise to a considerable height above the surrounding land. A large orchard north of Sturgeon Bay is located on such a plateau. In places there are very pronounced steep slopes or escarpments. Beginning several miles north of Sturgeon Bay there occur rugged limestone cliffs ranging in height from 20 to over 100 feet. These are confined largely to the Green Bay side and to the north end of the peninsula. Owing to the undulating topography, the natural drainage is good except in a few small depressions.

Origin.—The Miami loam has been derived from glacial material which has undergone considerable weathering. The drift contains considerable limestone material, but bowlders of other kinds of rock also are intermixed with the soil. It is probable that most of the soil was originally ground by the glacier from the underlying limestone.

Native vegetation.—The original vegetation consisted of oak, maple, basswood, elm, balsam, beech and white pine. In numerous unimproved areas a second growth of poplar has sprung up.

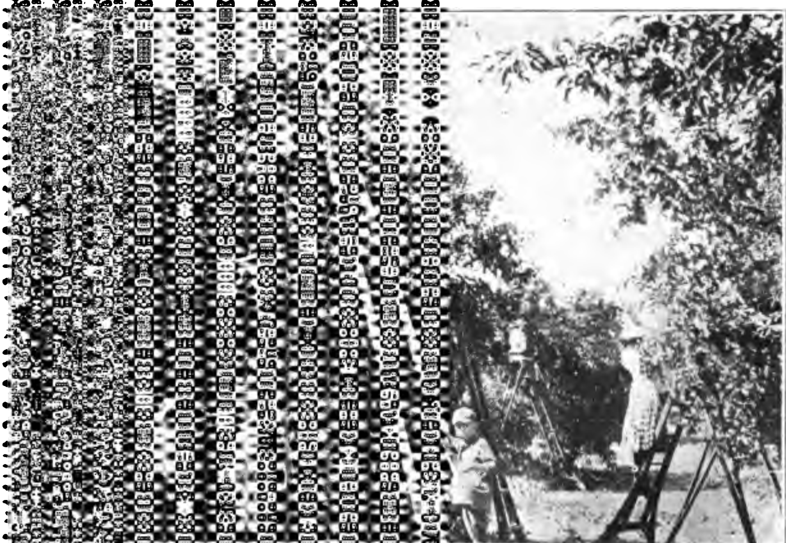
Present agricultural development.—About 60 per cent of the Miami loam is under cultivation. Aside from fruit growing, which is a very important industry on this soil, general farming is the most important type of agriculture. Until a few years ago the tendency was to go more and more extensively into fruit growing, but within the last year or two dairying is becoming more important. The principal crops produced are oats, barley, rye, peas, hay, and corn. Corn does not always mature before the first killing frost in the fall, but it always makes sufficient growth to produce good silage. In the vicinity of Sturgeon Bay, where a pea cannery is operated, a considerable acreage is devoted to the growing of peas for canning. The most important fruit grown is the cherry. Apples, plums, currants, grapes, strawberries, and other small fruits and berries are also grown on a commercial scale.

This soil is not hard to handle. The drainage is nearly always thorough, and the soil is sufficiently loose and mellow to make tillage easy. Where the soil is shallow, that is, only slightly over 1 foot deep, crops soon suffer in dry periods. The type is almost invariably plowed in the fall except in the case of or-



...ARD ON MIAMI LOAM.

...in Door County, and the fruit in- ...pe of soil. This view shows the ...ly planted between the rows in



...DOOR COUNTY.

...he largest cheery orchard in the ...ent and recreation to large num-

chards, which are usually plowed in the spring. Stable manure is the only fertilizer used for general farm crops. Where cherries or other fruits are grown there is a tendency to apply much of the manure to the orchard, at the expense of the other crops.

There are included with the Miami loam on the map and indicated by means of symbols, isolated areas which differ only in their extreme stoniness. The surface 8 inches consist of a friable, brown loam, which is underlain by a lighter colored loam or sandy loam. The depth to bedrock is variable, but is usually less than 3 feet. Bowlders, large and small, are scattered over the surface. Excepting the Rough stony land, it is the most stony soil in the county. It is of very small extent and of little importance. Small areas are scattered throughout the northern part of the county in association with the other Miami soils. Only a small proportion of the land is cleared, and this is used almost wholly for pasture, as the stoniness practically prohibits cultivation. The soil is not included with the Rough stony land because of the possibility that the stones may eventually be removed and the land placed under cultivaiton, while the Rough stony land apparently will always be nonagricultural.

Areas of the Miami loam in which the underlying limestone rock is more than 3 feet below the surface are distinguished on the map from the typical soil by means of symbols. The surface soil to an average depth of 8 inches consists of a rather heavy, brown loam. With a few exceptions it is practically free from gravel, and stones are not as numerous as in the typical areas. The subsoil consists of a yellowish-brown loam which usually becomes slightly heavier with depth. In some areas, which are indicated on the map by symbols, the subsoil is so heavy and sticky that the drainage is very deficient. The deep areas of Miami loam occur largely in the towns of Sturgeon Bay and Sevastopol. Smaller areas are scattered through the county. The surface varies from gently undulating to undulating, with some small nearly level areas in hollows or other depressions. In places where the heavy subsoil occurs, and where the drainage is deficient unless the slope is quite steep, cherry trees do not thrive as well as on the shallower soils where the heavy subsoil is lacking, and in several instances cherry orchards have

died. The soil retains moisture well, and crops suffer less during long dry spells than on most of the other soils of the county. The deep areas of Miami loam are productive, and probably over 80 per cent of the soil in under cultivation. The remainder is still in forests or is used as pasture. The original timber growth was the same as on the typical soil. Some of the finest and oldest cherry orchards in the county are located on the deep areas of Miami loam. Where the subsoil is not too heavy cherries do better than on any other soil. Farm crops of all kinds produce good yields. Oats, barley, rye, potatoes, corn, and hay are grown extensively. Clover and alfalfa do well and are increasing in acreage each year. Dairying is becoming quite an important industry, a considerable number of pure-bred dairy herds being kept. In general, the same methods of farming are followed as on the typical soil. The drainage is not as thorough in all places, however, and tile drains could profitably be installed.

A shallow variation of the Miami loam is also distinguished on the map. It consists of a brown, friable loam, which remains unchanged until just above the bedrock, where a thin, compact layer of loam or clay loam occurs. This lower layer contains numerous fragments of partially decomposed limestone, and angular limestone pebbles often occur on the surface and through the soil. Bedrock is invariably reached at depths of 3 to 12 inches below the surface. Stones are quite numerous, in many places seriously retarding cultivation. Rock outcrops are more numerous than in the areas of typical Miami loam. The shallow variation is rather unimportant soil. It occurs in small areas in various parts of the county, associated with the other types of the Miami series. The surface is mainly undulating to gently rolling, but there are small plateaulike areas where the surface is nearly level. While this soil occurs in the glaciated region it is probably in part of residual origin. In passing, the glacier scraped the rock free from soil and left no deposit. The weathering of the rock has produced the thin mantle of soil. The angular gravel, stones, and fragments of the bedrock mixed with the soil indicate that it is largely of residual origin. A smaller proportion of this shallow soil is under cultivation than of the typical Miami loam. Some of it is used for pasture and some is still forested, the timber consisting chiefly of oak,

maple, balsam, and pine. Cherry trees are grown considerable success on this shallow soil, as the roots enter cracks and crevices in the rocks. The same methods of farming, fertilization, and crop rotation are followed as on the typical Miami loam.

The selling price of land of the typical Miami loam is quite variable, depending upon the location and development. In the vicinity of Sturgeon Bay the price is high, but in the northern end of the county near Ephraim and Ellison Bay improved land can be purchased for \$40 to \$60 an acre. Thrifty cherry or apple orchards which have come into bearing sell for \$400 to \$600 an acre.

The following table gives the results of the mechanical analyses of samples of the soil and subsoil of the Miami loam:

Mechanical analyses of Miami loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Soil	1.4	4.1	5.4	28.2	17.5	34.2	9.0
Subsoil	1.6	4.2	5.8	33.3	19.8	25.9	9.6

MIAMI FINE SANDY LOAM.

The Miami fine sandy loam is quite widely distributed throughout the county, chiefly north of Sturgeon Bay, where it occurs in association with other soils of the Miami series. It is most extensively developed in the towns of Sevastopol and Liberty Grove. More than one-third of Washington Island is occupied by this soil. It covers a total area in the county of 30,528 acres, and is one of the four most extensive types of soil in Door County.

The surface soil consists of a friable, brown to grayish-brown fine sandy loam, about 8 inches deep. In some areas gravel occurs on the surface and in the soil mass, while in other places the texture may approach that of a sandy loam. The line separating this type from the Miami loam could not everywhere be sharply drawn. Bowlders in considerable numbers were originally found upon the surface, and rock outcrops are quite

common. The subsoil to within about 2 inches of the bedrock is composed of a yellow light-brown fine sandy loam. In some places the material in the lower depths is quite sandy, but directly overlying the rock there is a thin layer of darker colored, sticky loam which carries scattered fragments of partially decomposed limestone.

There are only slight variations in this type. The depth to bed-rock varies considerably, although it is usually less than 3 feet. On the highest hills and in the most rolling areas there is usually a considerable depth of glacial débris above the bedrock. In sections 9, 16, 20, 21, and 29, Claybanks town, the subsoil is heavier and the depth to the underlying limestone much greater than typical. In places the deep subsoil is a red clay, and in some of the road cuts this clay appears at depths varying from 3 to 7 feet.

The surface of the type varies from undulating to quite rolling. Occasionally it occupies long ridges. On account of the surface relief and the sandy texture the drainage is excellent. In the most sandy areas it is excessive and the soil tends to be droughty.

The Miami fine sandy loam has been derived from the weathering of glacial drift which occurs chiefly in the form of ground moraine, although there are a few kames and drumlins included in the type. Ground-up material from the underlying limestone has entered largely into the composition of the soil, although the presence of granitic bowlders shows that at least a portion of the drift must have come from farther north.

The original forest growth consisted chiefly of maple, birch, balsam, basswood, white pine, and different varieties of oak.

The Miami fine sandy loam is an important type agriculturally. Probably over 60 per cent of it is under cultivation, the remainder being in woodlots or used for permanent pasture. While the average yields of general farm crops are not quite as high as on the Miami loam, it is a fairly good soil. It is best adapted to such crops as potatoes, corn, rye, and truck gardening. While there are a number of fairly good cherry orchards on this soil the general opinion seems to be that it is not as well adapted to cherries and other fruits common to the region as is the Miami loam type of soil.*

* For a discussion of the chemical analysis and methods for the improvement of this soil see page 33.

SUPERIOR LOAM.

[ROLLING PHASE.]

Extent and distribution.—The Superior Loam, rolling phase, is the most extensive and important soil in the southern part of Door County, and it is the second soil in extent in the whole county. The total area is 53,760 acres. With the exception of a small area in section 5 in the Town of Sturgeon Bay, and another in section 7 in the Town of Sevastopol it is confined entirely to the portion of the county south of Sturgeon Bay. Here it is closely associated with Superior clay, from which it was frequently difficult make a clear distinction.

Description.—The surface soil consists of a grayish-brown loam varying in depth form 10 to 20 inches. It contains some angular gravel and fragments of limestone in places, bowlders are abundant on the surface in some areas, and here and there the bedrock outcrops. As in the case of the other timbered upland soils, the supply of organic matter is low. The subsoil consists of a brownish-red to chocolate-colored clay loam which contains sufficient sand and other coarse material to give it a gritty feel. The gravel, rock fragments, and bowlders consist largely of limestone, but some rocks foreign to the region are encountered. The depth to the limestone bedrock varies, but is more than 3 feet in most places. The subsoil of this type in Door County is somewhat different from that of the typical Superior loam as it occurs on the shores of Lake Superior. It contains much more coarse material and therefore lacks the smooth, plastic feel of the typical subsoil. Glacial action is doubtless responsible for the modification.

The texture of this soil type is very uniform. The principal variations are in the depth of the underlying rock and in the quantity of stones on the surface. In the northern part of Nasewaupee Town, in much of Gardner Town, and in sections 3 and 4 of Brussels Town, the depth of bedrock is less than usual, being in many places less than 3 feet. Rock outcrops and stones are more numerous here than in the typical areas. In the immediate vicinity of outcrops and where stones are numerous, both which conditions are shown on the map by symbols, the soil is usually shallow.

Topography and drainage.—The surface varies from gently undulating to gently rolling. In general it is not rolling as are the Miami soils, and only a very small part of the type is excessively rough or broken. In the town of Claybanks high bluffs rise a short distance back from the lake shore. The natural drainage of the type is good except in depressions or along the borders of marshes or of low-lying soils like the Poygan. In such places tile drains could be profitably installed. On the tops of some of the knolls and hills the surface soil has been washed away, leaving the subsoil exposed. Such spots, however, are rare, and erosion is not serious.

Origin—The Superior loam, rolling phase, has originated partly from lacustrine and partly from glacial material. The red clay was deposited in the quiet waters of a lake before the Glacial Period. The glacier mixed this clay with gravel bowlders, and rock fragments, and left the surface undulating and broken. The underlying limestone was broken and crushed, giving rise to fragments which now are scattered through the soil and subsoil. Through the long intervening period of weathering the lime has been leached from the surface material, so that it is now usually in an acid condition.

Native vegetation.—The original timber growth on this type consisted of both pine and hardwoods. In some sections white pine predominated, in other areas hardwoods alone grew, while in still others hemlock, pine, and hardwoods formed a mixed growth. The principal hardwoods were maple, birch, basswood, beach, elm, and some oak and hickory. All the valuable timber was removed long ago, and in many places a second growth of birch and poplar has sprung up.

Present agricultural development.—The Superior, loam rolling phase is highly improved, and the greater part of it is under cultivation. Some of the largest and most up-to-date farms in the county are on this soil. General farming, with dairying as the principle side line, is carried on. The most important crops produced are oats, peas, barley, rye, corn, timothy, clover, and potatoes. On most farms the chief source of income is dairying, which is rapidly becoming more important. Many pure-bred herds, principally Holstein and Guernsey, are kept. The soil produces excellent yields of hay, while corn, although it does not always mature, never fails

to reach the stage where it can be used for silage. Many farms are now equipped with silos, more of which are being constructed yearly. In the vicinity of Sawyer some peas are grown for canning, and in areas near the water cherries and apples are grown. The type, however, is not as well adapted to the growing of fruit as are the Miami soils. Oats are grown more extensively than any other grain. Yields ordinarily range from 30 to 50 bushels per acre. Barley yields 20 to 35 bushels, rye 15 to 20 bushels and potatoes 125 to 200 bushels. Timothy and clover produce heavy crops.

Land of this type sells for $75 to $125 an acre, depending on the location and improvements.

This soil works up readily and is on the whole quite easily handled, in spite of the heavy subsoil. Fall plowing is practiced almost exclusively. In some of the more nearly level areas some system of artificial drainage should be installed. Stable manure is the only fertilizer used to any extent. Often the crop rotation followed is not the one best suited to conditions. The organic content of this type is low.

The following table shows the results of mechanical analyses of samples of the soils and subsoil of the Superior loam, rolling phase.

Mechanical analyses of Superior loam, rolling phase

Description	Fine gravel	Coarse sand	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Soil..................	1.0	3,6	4.5	20.8	23.1	37.6	8.9
Subsoil.............	.7	3.7	5.2	22.8	19.1	30.2	18.5

SUPERIOR FINE SANDY LOAM.

[ROLLING PHASE.]

This is a soil of minor importance, there being only 1344 acres in Door County. The largest tract occurs in sections 27 and 28 in the town of Union. Small areas are also found near the bay shore in sections 30 and 31 Sevastopol Town.

The upper 8 inches of this soil consists of a brown fine sandy loam which is underlain by a lighter colored fine sandy loam to fine sand which extends to an average depth of about 30 inches. The deep subsoil consists of a heavy, red clay which extends to the bedrock. Some gravelly material occurs in the soil and subsoil, and bowlders are scattered over the surface in places. In a number of places the surface soil is lighter in texture than typical. In the town of Claybanks just back of the strip of lowland along the lakeshore much of the material classified as Miami fine sandy loam is like the Superior series in the presence of a red clay substratum, but the depth to this stratum is so great as to have little influence on the soil and it therefore is mapped with the Miami series.

The type has a gently rolling to rolling surface. In section 30, Sevastopol Town, it occurs on a long, high hill, with a few rock outcrops on the slope. The type has good natural drainage, and on account of the clay subsoil it retains moisture very well, except possibly in the area of Sevastopol Town, where the rock is close to the surface.

In origin this soil is similar to other types of the Superior series, being partly lacustrine and partly glacial. The surface is very often found to be acid, owing to the leaching of the lime carbonate. The red clay subsoil usually contains considerable carbonates, especially in the lower depths.

The original timber consisted chiefly of maple, beech, basswood, oak, hickory and some pine.

Agriculturally this soil is unimportant. A considerable proportion is still unimproved. The area north of Sturgeon Bay is largely forested and has an unfavorable topography. Where under cultivation this soil is easy to handle, and good yields of the general farm crops are secured. The methods followed are practically the same as on the Superior loam.*

CHEMICAL COMPOSITION AND IMPROVEMENT OF LOAMS AND FINE SANDY LOAMS.

* * * * *

These soils are more open in texture than the group of heavy soils. They have a water holding capacity which is suf-

* For a discussion of the chemical composition of this soil and its improvement see page 37.

ficient to insure good pasture, where the land is in grasses. Because of the more rolling surface, the higher content of fine sand in the surface soil, and the open or rocky subsoil the natural drainage is much better than on the heavy level lands and the soil thus warms up earlier in the spring and does not have the tendency to bake and crack which is characteristic of some of the heavier soils. These qualities make these types better adapted to such crops as corn and potatoes, and also to the growing of fruit. It is on this group of soils chiefly that the extensive fruit industry of Door County has been developed.

The total amount of the plant food elements phosphorus and potassium is nearly but not quite as large in the loams and fine sandy loams, as in the group of heavy soils previously described. The amount of organic matter is somewhat smaller, as is also the supply of nitrogen. Because of this and the coarser texture the rate of chemical change may not always be as rapid as in the heavier soils. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or commercial fertilizer becomes more important, especially when crops are grown which are sold from the farm.

An increase of the supply of active organic matter in these soils is of great importance. It is desirable to have nearly twice as much organic matter in the soil as these types now contain. The plowing under of legumes, such as the second crop of clover, or a crop of soy beans is a good way of securing this result. The supply of stable manure is usually too limited to meet the needs of the entire farm.

As in the group of heavy soils in this county, and as is quite common in most of the state the phosphorus content of these soils is below normal, and should be increased. Even the use of stable manure will not itself supply the amount of phosphorus needed, and it is a good plan to supplement the use of stable manure with a phosphate fertilizer. Acid phosphate is the most quickly available and under present conditions is doubtless the most profitable form to use. This may be applied with small grain which is seeded to clover and about 250 to 300 pounds per acre should be used. When used with corn it may be drilled in the row with a fertil-

izer attachment to a corn planter, or drilled in with a regular lime and fertilizer sower just before the corn is planted.

Where general farming is followed and it is desired to build up the organic matter supply the following rotation is a good one to use:—Corn or a cultivated crop one year, followed by a small grain with which clover is seeded, the first crop the following year cut for hay, and the second plowed down as a green manuring crop to be again used for a cultivated crop. When commercial fertilizer is used it may be applied with the small grain or to the corn crop. Where a second crop of clover is not turned down it should be fed and the manure returned to the field in as liberal amounts as can be secured.

The growing of alfalfa could be greatly extended on these soils and every farmer should consider the question of starting a small acreage.

In connection with the handling of these soils for fruit growing it may be said that the use of commercial fertilizers has not come into general practice. In some other regions, however, it has been found that the use of nitrate of soda has greatly increased both vigor and production, and in some cases mixed fertilizers have also given profitable results. The work in Wisconsin along this line, however, has been so limited that it is not considered advisable to attempt to give specific recommendations for the use of commercial fertilizers for fruit growing.*

In some cases the surface soil of these types is found to be somewhat acid. Where this is the case ground limestone may be applied at the rate of 2 tons per acre or more, depending upon the degree of acidity. The limestone may be applied at any convenient time but it is probably best to put it on the small grain crop which is being seeded to clover. It may be applied with a regular lime sower after the ground has been prepared for seeding. It should be worked well into the soil but should not be plowed under.

* The Agricultural Experiment Stations in New York, Pennsylvania, Ohio, and Indiana have given this question study and those interested are directed to consult the publications issued by these Stations on the fertilization of orchards.

CHAPTER IV.

GROUP OF POORLY DRAINED SOILS.

POYGAN LOAM.

There are only 3, 584 acres of Poygan loam in Door County and this occurs in tracts of from 20 to 200 acres mostly in the Towns of Brussels, Garden, and Nasewaupee, in the southern part of the region covered by the survey. It is associated chiefly with the Superior soils.

The Poygan loam, to a depth of 8 to 10 inches, consists of a heavy, black loam, high in silt. The subsoil is a heavy, red clay, similar to that of the Superior series, but below 24 inches the red clay is usually mixed with fragments of partially decomposed limestone. Bedrock is sometimes encountered within 3 feet of the surface.

The Poygan loam has a level surface, and on account of its low, swampy position and heavy, tenacious subsoil the drainage is very deficient. In some areas water stands on the surface a large part of the year.

The type is largely of lacustrine origin, but has probably been influenced slightly by glacial action. The decay and accumulation of a dense growth of vegetation through long periods has resulted in the dark color and high content of organic matter. The surface soil is acid, but the subsoil ordinarily is neutral or calcareous.

Only a very small percentage of the Poygan loam is under cultivation. Much of it remains just as it was left after the timber was removed. The forest growth consists of cedar, ash, elm, birch, and hemlock, with a second growth of poplar in some areas. In other sections of the State similar soils have been drained and made to produce good yields of the common crops. The type is well adapted to the growing of grasses. It is heavy and quite difficult to handle and before it can

be worked successfully and made to produce profitable yields it must be thoroughly drained.*

CLYDE SILT LOAM.

This is a soil of minor importance, there being only 1,536 acres in the county. It occurs in patches of from a few acres to about 100 acres and is scattered throughout nearly all parts of the county.

The Clyde silt loam, to a depth of 8 to 12 inches, consists of a very dark colored silt loam. This is underlain by a subsoil of heavy, slightly mottled, bluish silt loam or clay loam. The lower depths contain considerable limestone fragments and gravel.

Variations occur in texture, color, and depth to bedrock. In some depressions a shallow layer of peat may occur on the surface, while in other spots the surface soil may approach a loam in texture. In some places the subsoil may be sandy. The depth to bedrock varies, the minimum being about 2 feet.

The surface is level, and owing to its low position and heavy subsoil the type is wet, soggy and the natural drainage is very deficient.

The type is of both glacial and waterlaid origin. Large accumulations and decay of organic matter in the presence of moisture have resulted in the high content of organic matter and the dark color.

Only a small part of this type has been cleared and most of this is used for pasture. The original forest growth consisted of elm, ash, cedar, birch, and willow. The principal need of the type is better drainage. Most of it can be drained and made into good land, as it is inherently productive. In other parts of the State similar soils when drained produce good yields of corn, cabbage, hay, and various other crops.

CLYDE LOAM.

The Clyde loam covers a total area of 6,208 acres, and is found in small tracts scattered throughout the greater part of Door County. It is associated chiefly with the Miami soils, and occupies depressions between hills or along streams, or along

* For a discussion of methods for the improvement of this soil and the chemical composition see page 46.

the border of marshes. The size of tracts varies from a few acres to 100 or more acres.

The Clyde loam consists of about 12 inches of black, mellow loam containing considerable silt and organic matter, underlain by a subsoil of grayish fine sandy loam which becomes lighter colored and lighter in texture with depth. The deep subsoil is reddish in color, heavy, and compact.

The type is subject to some variation. In depressions there may be a thin layer of peat on the surface. In places 5 or 6 inches of fine sand may be encountered immediately underlying the surface soil. The texture of the subsoil may vary from a fine sandy loam to a clay loam. The depth to bedrock ranges from 2 feet to several feet.

A lighter textured soil is included with this type on account of its small extent. To an average depth of 8 inches it consists of a very dark colored fine sandy loam, underlain by a grayish fine sandy loam which becomes lighter colored with depth. In all other respects it is similar to the Clyde loam. Owing to the level surface and low position the natural drainage is poor. The water table is within a few feet of the surface and during heavy rains in the spring and early summer the water stands on the surface for a long time.

The surface soil of this type is slightly acid in places owing, it is thought, to acids formed by the decay of organic matter in addition to the leaching out of lime from the soil.

This type of soil occurs in depressions where the material has been washed in to some extent from adjoining higher land. Where it is found along streams it is partly alluvial and in other places it is largely glacial, but it has all been modified by the addition of large amount of decaying vegetable matter, which accounts for the dark color.

A large part of the Clyde loam is still unimproved. In its present undrained condition it can be used only for pasture. Much of it is too wet and too thickly covered with brush to be used even for this purpose. The timber growth consists of elm, ash, willow, and cedar, with some birch and alder and other water-loving trees.

Where thoroughly drained this soil is well suited to nearly all the common farm crops, and especially to grasses. The virgin soil is high in organic matter. In other parts of the

State similar soils when improved have given excellent yields, returning the cost of drainage in a comparatively short time.

CHEMICAL COMPOSITION AND IMPROVEMENT OF POYGAN LOAM, CLYDE LOAM AND SILT LOAM.

Since these soils are formed along the border line between upland light colored soils and peaty and muck marsh soils, they are intermediate in chemical composition between these two extremes. Moreover, their position is such that they have received a considerable deposition of fine silt from the higher land with its larger content of plant food. These soils have in the surface 8 inches approximately 2000 pound of phosphorus per acre; from 30,000 to 40,000 pounds of potassium; and approximately 10,000 pounds of nitrogen. Since they are surrounded by highland, the subsoils of which are rich in ground limestone which is being continuously dissolved and carried to the lower lands by percolating waters, they are as a rule not acid, and in fact usually contain considerable quantities of lime carbonate.

In spite of their large content of both phosphorus and potassium, it is not infrequently true that these soils show low availability of these elements, especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthy part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers, as suggested in the bulletins of the Experiment Station.[1]

The most important question in the improvement and management of these soils is one of drainage. Practically all areas are in need of drainage, and tile drains will be found most practical in the majority of cases. When properly drained and well managed, very satisfactory yields can be secured.

* For more information write to Wisconsin Experiment Station for bulletins on drainage and fertilization of low, poorly drained tracts of land.

For special information on drainage, see Bulletin No. 229 of the Wisconsin Experiment Station.

Cabbage, onions, and sugar beets are some special crops which can be successfully raised on these soils, aside from the general farm crops, such as timothy, alsike, clover, and corn. Stable manure should not be applied to these soils as the nitrogen is not needed. The mineral elements, where needed, may be supplied in the form of commercial fertilizers, as indicated above.

PEAT.

There are approximately 60 square miles of Peat in Door County. A little more than half the type occurs in that part of the county south of Sturgeon Bay. The largest area is mapped near the east shore of the peninsula in the northern part of the county, extending from a point just north of North Bay to Baileys Harbor. Between the shore and the swamp there is a narrow strip of high land. The points projecting into North Bay, Mud Bay, and Baileys Harbor are extremely rocky. This marsh covers about 13 square miles. Another large marsh extends from a point about 3 miles south of the Sturgeon Bay ship canal to Clark Lake, reaching one-half mile to about 1½ miles inland. Like all the large marshes along the Lake Michigan shore it is separated from the lake by narrow strips of high land, mainly beach sand. To the north of Sturgeon Bay the western part of the county is practically free from peat marshes; the only two of importance are the one extending southeast from Ephraim and the one extending southeast from Ellison Bay. In the region of the Superior soils to the south of Sturgeon Bay there are numerous areas of Peat of various sizes. The largest is the one in sections 20, 21, 22, 26, and 28, Gardner Town. Other areas of over 1 square mile occur in Nasewaupee, Forestville, and Brussels Towns.

Peat includes several kinds of swamp and marsh land the soil of which consists chiefly of roots, grasses, sedges, leaves, moss, and other organic matter in various stages of decomposition. There is usually incorporated a small amount of mineral matter. The soil is dark brown to black in color and 8 inches to several feet in depth, being shallow at the border of the marsh and deeper near the center. In some of the marshes the subsoil consists of extensive deposits of marl.

All the Peat lands are level and low lying. The drainage is poor, owing to the lack of drainage outlets or because of a

heavy, impervious subsoil below the organic soil. In the southern part of the county the subsoil is heavy, but in the large areas along the lake shore north of Sturgeon Bay it is more sandy and porous. In these large areas there occur islands of sand which are not shown on the map.

Most of the Peat areas of Door County are wooded, the growth consisting of cedar, tamarack, ash, willow, and some elm and spruce. Where the peat is deepest tamarack predominates, but along the border of the marshes or where the Peat is shallow ash, elm, and willow predominate. The largest open marsh in the county is the one extending from Ellison Bay to Rowley Bay.

Most of the Peat areas are wet the greater part of the year, and in the spring and during the wet seasons water stands on the surface. The slope is nowhere sufficient to drain the excess water without open ditches or tile. The large marshes along the Lake Michigan shore do not lie very much above the level of the lake, and drainage here would be quite difficult. Very little of the Peat land has been reclaimed, although many areas could be drained and profitably cultivated. Many small marshes could be drained at comparatively low cost. Reclamation of the larger ones would require large expenditures and the organization of drainage districts.

MUCK.

Muck consists of vegetable matter in varying stages of decomposition, with which there are incorporated large amounts of mineral matter. It is more thoroughly decomposed than Peat, contains more mineral matter, and may be considered as intermediate between Peat and the soils of the Clyde series. Practically all of the Muck is relatively shallow, and in some places the type as mapped consists of Peat underlain at 6 to 10 inches by silt loam or fine sandy loam. When plowed the soil here consists of a mixture of Peat and silt loam which has nearly the composition of true Muck.

Muck occurs only in small areas. These are scattered throughout the area, mainly along streams or at the border of areas of Peat. It occupies about the same topographic position as Peat, and is poorly drained and swampy. With drainage well established the soil is very productive, but in its present un-

drained condition it is only of value for the pasture it affords and the marsh hay which is cut from some areas.

CHEMICAL COMPOSITION AND IMPROVEMENT OF PEAT AND MUCK.

Peat has been largely formed by the accumulation of vegetable matter, particularly sphagnum moss and certain sedges and grasses. It is very low in earthy matter, running from 80 to 95 per cent of organic matter. The amount of mineral elements is consequently low, the total weight of phosphorus being approximately 600 pounds per acre to a depth of 8 inches, and of potassium, 700 pounds. It will be seen, on comparison of these statements with those made on the composition of such soils as Miami silt loam and Fox silt loam, that the total amount of potassium, in particular, is extremely small, the amount in peat often being less than 2 per cent. of that found in upland silt loam soils. While the total amount is small, a large proportion of it is available to plants, especially if the surface has been burnt over, and the supply may be sufficient for from 1 to 3 crops. It is to be expected, therefore, that profitable cropping is possible over a long period of years, only by the use of some form of potassium fertilizer, either barnyard manure, wood ashes, or the usual commercial fertilizers containing this element. The total supply of phosphorus is rather low, though the difference between the amounts present in Peat and upland soils is very much less than in the case of potassium. In the Muck soils there is a somewhat larger supply of phosphorus and potassium than in the Peat, because of the larger amounts of fine earth which are present. The total amount, however, is much lower than in good upland soils. In view of the enormous quantity of nitrogen contained in these soils, the average amount of which is over 15,000 pounds per acre 8 inches, it is unnecessary to use stable manure, the most valuable element of which is the nitrogen, so that on farms including both Peat or Muck land and upland soils, the stable manure should be used on the upland, and commercial fertilizers containing phosphorus and potash, if needed, on the lower land, unless, indeed, there is sufficient manure for the entire farm, which is rarely the case. These marsh soils are rarely acid on account of the percolation of lime-containing water from higher lands, though occasionally patches of Peat are found in the

larger marshes. This acidity, however, is not so dertimental in the case of marsh lands as in the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on the higher lands to secure nitrogen, but which are not needed on the marsh soils for this purpose, and to the growth of which, indeed, the marsh soils are not so well adapted physically.

In the improvement of Peat the question of drainage* is the first step to be considered. Both open ditches and tile drains can be utilized in reclaiming the marshy tracts. The major portion of Peat areas in Door County can be drained and improved, and efforts are now being extended along this line through the establishment of drainage districts. Some drainage work is also being carried on by individual farmers to reclaim small marshy tracts which have sufficient fall so that an outlet can be readily secured.

When thoroughly drained, properly cultivated and fertilized Peat will produce profitable crops of timothy and alsike clover, small grains, buckwheat, root crops, and in some regions such special crops as celery and peppermint are grown. When small grains are grown there is danger of lodging, but the use of commercial fertilizers will tend to produce a stronger straw. Corn can be grown also on Peat land but the danger from frosts is considerable greater than on the adjoining upland in the same vicinity.

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* For special information concerning drainage, write the Soils Department of the Wisconsin Experiment Station.

CHAPTER V.

GROUP OF MISCELLANEOUS SOILS.

MIAMI GRAVELLY SANDY LOAM.

The Miami gravelly sandy loam is not an extensive or important type. It covers a total area of 6,784 acres, or 2.3 per cent of the county. It occurs in all but the southern part of the county, occupying small areas associated with other types of the Miami series. Some rather large areas occur on Washington Island.

The Miami gravelly sandy loam is a somewhat variable type, but the greater part of it is either typical or included in a variation which is characterized by a level to undulating surface. The typical soil which has a rolling topography consists of a loose, light-brown sandy loam to an average depth of about 8 inches. Gravel and bowlders in varying quantities and sizes occur on the surface and through the soil. The sub-soil is a reddish-brown, gravelly sandy loam. The gravel content increases with depth, and the subsoil in places is a bed of pure gravel. The undulating areas have a typical surface soil, but the soil here is shallow. It occurs on the points projecting into Lake Michigan and near the shore on the east side of the peninsula. Bowlders and outcrops of limestone are common, and the bedrock occurs at depths varying from 1 to 3 feet.

The topography of the typical areas is rolling to broken and bumpy, consisting to a considerable extent of hills, knolls, and long narrow ridges. The drainage is thorough and rapid. The gravelly nature makes the soil rather droughty, but in seasons of sufficient rainfall fair yields are produced.

The typical Miami gravelly sandy loam has been derived from glacial material, and occurs in the form of eskers, drumlins, and moraines. The undulating variation also has been derived from the weathering of glaciated material, but this

was not left in morainic form as in the case of the typical soil.

A considerable proportion of this type is under cultivation. Some of it is still in forest. The original timber growth consisted chiefly of oak, pine, maple, and some other hardwoods. This class of land is used chiefly for general farming, but because of its rather coarse texture, open structure, and consequent droughty condition average yields are considerable lower than on the heavier soil types of the Miami series. Profitable crop production on this soil requires careful management.*

MIAMI GRAVELLY LOAM.

This soil covers an area of 7,616 acres or 2.5 per cent of the county. While of limited extent it occurs in numerous areas varying in size from a few acres to one-half section or more. It is confined to that part of the county north of Sturgeon Bay and is associated with other types of the Miami series.

The surface soil of the Miami gravelly loam consists of a friable, brown loam, which extends to an average depth of 8 inches. There is a large amount of gravel on the surface and through the soil. Much of the gravel is angular, and frequently the particles are quite large. The surface soil grades into a light-brown or yellow gravelly fine sandy loam. The content of gravel increases with depth, and it is usually impossible to penetrate the deep subsoil on account of the gravel.

This is one of the most rolling soils in the county; in fact, the rolling topography is one of its most characteristic features. It occurs on drumlins or eskers or in areas of choppy or broken land in the morainic sections. The rolling topography and gravelly subsoil make the type droughty. Erosion is active in periods of heavy rains.

Agriculturally this is not an important soil although a considerable portion of it is cleared and some of it is cultivated. While about the same crops are raised upon it as on the heavier soils, the average yields are much lower. Most of it can be used to best advantage for grazing.*

* For a discussion of the chemical composition and improvement of this soil see page 49.

* For suggestions on the permanent improvement of this soil see page 49.

MIAMI FINE SAND.

There are 4,800 acres of Miami fine sand in Door County. This occurs in small patches on Washington Island and over most of the Peninsula as far south as the region of red clays in the southern part of the county.

The Miami fine sand consists of a yellowish-brown fine sand, 6 to 10 inches deep, underlain by a pale-yellow fine sand which becomes a little coarser with depth. The soil is loose and open and very low in organic matter. When the surface is bare it is sometimes blown by the wind.

The surface is gently rolling to rolling, and owing to this and to the loose, open character of the sand crops suffer from drought except when the rainfall is heavy and well distributed. This soil has been farmed with varying degrees of success. Much of the type is still uncleared, although the original timber has long since been removed. This consisted largely of pine and of oak, with varying proportions of other hardwoods.

In wet seasons when the rainfall is well distributed good yields of the common farm crops are obtained. Potatoes, corn, rye, oats, buckwheat, and truck crops give the best results. Some cherry orchards have been planted on this soil, but they have either made a very poor growth or died out entirely.

The Miami fine sand is easily plowed and cultivated. It becomes dry and warm very quickly, and can be worked earlier in the spring than the heavier soils and under a much wider range of moisture conditions. On the other hand, it is low in water-holding capacity and subject to wind erosion.*

A few widely scattered areas of coarser sand are included on the map with Miami fine sand. It is similar in origin, topography, and all other features except texture. The surface soil of the sand type to an average depth of 8 inches consists of a yellowish-brown sand of medium texture. It is loose and open in structure, and low in organic matter. The subsoil is a pale-yellow sand which becomes a little coarser with increased depth. Most of this type is still uncleared, although the original timber has long been removed. This consisted chiefly of pine and oak, with scattered balsam and hardwoods other than oak. The soil has the same agricultural adaptation as the typical

*Methods for the improvement of this soil are discused on page 33.

Miami fine sand, and it should be handled in the same way in order to obtain profitable yields.

PLAINFIELD SAND.

This type is confined to Chambers Island in Green Bay and a small area south of Clark Lake in Sevastopol Town. Chambers Island, which has an area of about 4 square miles, is occupied almost entirely by Plainfield sand.

The Plainfield sand consists of a light-brown, loose sand to a depth of 8 to 10 inches. The subsoil is a light-colored sand which assumes a marked yellowish tinge in the lower depths. The little gravel that occurs consists maily of chert, quartz, or quartzite. The soil is very uniform throughout its development.

The surface of this type is level to gently undulating. It was originally more nearly level than at present, wind and other agencies having changed the topography slightly. The crops suffer from lack of water during at least a part of nearly every season.

Only a very small total area of the Plainfield sand is cleared and under cultivation. The original timber growth consisted largely of white pine, with various kinds of oak, maple, and other hardwoods in varying amounts. On Chambers Island a thrifty growth of young timber, mainly pine, is springing up. The principal use of the type here is for a game preserve and for summer homes.

In wet years when manured heavily this soil has given fairly good yields of different crops. Corn, potatoes, rye, buckwheat, and truck crops are well adapted to the Plainfield sand.

PLAINFIELD FINE SAND.

The Plainfield fine sand covers less than 2 square miles and is one of the least important types in the county. It is confined to two areas, one on each side of the peninsula. One area occupies a narrow terrace lying between the foot of the high bluffs and the Lake Michigan shore in Claybanks Town; the other occurs along the Green Bay shore in sections 28, 21, and 16, Union Town.

The surface soil of the Plainfield fine sand is a light-brown to dark-brown fine sand or loamy fine sandy, about 8 inches

deep. The subsoil is a lighter colored fine sand, with a marked yellow tinge in the lower depths. Red Clay is usually encountered at 3 to 6 feet below the surface. In the area at the foot of the bluffs along the lake shore.

The surface of the type is level to slightly undulating, and it lies only 5 to 15 feet above the level of the lake, but the natural drainage is good except at the foot of the bluffs, where seepage from the highland keeps the soil wet.

This soil has been brought to its present position by the action of water. The terrace on the Lake Michigan side was probably formed when the water level was higher than it is now, the sand in both areas being undoubtedly Beach sand. The red clay subsoil which underlies the sand is also waterlaid.

Only a small proportion of the Plainfield fine sand is under cultivation. The original timber growth consisted of scrub oak, mixed hardwoods, and some white pine and hemlock. The yields of the common farm crops are lower than on the heavier soils, but such crops as potatoes, strawberries, and truck do very well.

The area in Union Town is low in organic matter Stable manure, is the only fertilizer used. The soil is well adapted to the growing of truck, and trucking could well be more highly developed.

CHEMICAL COMPOSITION OF FINE AND MEDIUM SANDS.

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These soils are of limited extend and for their highest development require more careful management than the heavier types of soil above described.

They are quite dificient in organic matter and nitrogen. The nitrogen content usually ranges from 1000 to 1500 pounds per acre in the surface 8 inches. The phosphorus supply is also low and averages from 850 to 900 pounds per acre. The potassium in the surface 8 inches per acre is approximately 25,000 pounds which is only about half the amount present in the heavy soils of the county.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other live stock farming is prac-

ticed it will be less difficult to maintain the supply of the essetial elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained, it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover occasionally all of which is to be plowed under as a green manuring crop will be found profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necéssary to maintain the soil at a point of productivity for a considerable number of years. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen. and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover, and there is little loss in so doing since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

In the improvement of these soils it will be found that the fine sand will respond more readily than the sand, because of the difference in texture. On the fine sand potatoes can be grown in rotation with greater profit than on the sand. For the extremely sandy soils of medium texture better results are secured when corn is used as the cultivated crop in a rotation. For the sand a rotation of corn, small grain and clover is good, while on the fine sand potatoes may be substituted for the corn. In both cases the second crop of clover should be plowed under.

ROUGH STONY LAND.

Rough stony land includes areas so rough, broken, or rocky as to be of little or no value for farming. It occurs largely

in long, narrow strips in the form of high bluffs, slopes, or steep cliffs. It is practically all confined to the west side of the peninsula, where it occurs either on the shore or a short distance back from the shore, and represents either the present or a previous shore line. The longest area of Rough stony land extends from a point about 5 miles northwest of the city of Sturgeon Bay to a point about 3 miles north of the village of Egg Harbor. The type includes the bluffs at Fish Creek, Ephraim, Sister Bay, and Ellison Bay, and those in the State park. On the point of land between North Bay and Mud Bay the type is much more nearly level than typical, but the extensive rock outcrops, the stoniness, and the extremely shallow soil render the land practically valueless for agriculture. On the slopes and cliffs extensive outcrops of limestone occur.

The timber growth on the Rough stony land consists of maple, birch, balsam, pine, and poplar. The best of the timber has been removed, but considerable remains and should be left to protect the slopes from washing.

Over some of the slopes there is only a shallow covering of soil, while some areas are well covered. The soil varies from fine sandy loam to loam. No attempts have been made to cultivate this land, but it may furnish some pasturage.

BEACH SAND.

The type mapped as Beach sand consists of a grayish fine or very fine sand which continues with little change throughout the 3-foot section, except that the subsoil has a marked pale-yellowish tinge. There is little or no organic matter in the soil.

This type is confined largely to a narrow strip bordering Lake Michigan from a point a short distance south of Sturgeon Bay ship canal to the north end of the peninsula. It varies in width from three-fourths to less than one-fourth mile, but is not continuous along the entire east side of the county. The widest and most typical area occurs at Jacksonport. Some small areas are mapped on Washington Island.

The surface of this soil varies from undulating to very rolling or bumpy, being typically quite rolling. Drainage is excessive, and crops suffer from lack of water except in very wet seasons.

Beach sand consists of material washed onto the shore by the waves. Much of it has been drifted by the wind, forming the broken, bumpy surface, and a considerable proportion consists of shifting sand dunes.

On account of its low productiveness and other unfavorable features only a small part of this soil is under cultivation. The timber consists mainly of pine and oak, neither of which grow very large or dense. The type is not likely to be farmed extensively for some time. Rye, oats, corn, and potatoes, are grown, but the yields are low except very near the shore, where the water of the lake is but little below the surface of the land.

The system of farming on this soil should be such as to increase its content of organic matter and its water-holding capacity. Stable manure should be supplemented by green-manure crops, the soil should be limed, and commercial fertilizers used. Great care should be taken to guard against wind erosion. The type is better adapted to the production of truck crops than to general farming, but owing to the long distance to market the trucking industry has not been developed.

Some small areas of gravel are included with the Beach sand as mapped. The soil in such areas consists of about 4 inches of gravelly sandy loam underlain by beds of gravel and sand. It occurs in very narrow strips along the shore, largely on the Green Bay side of the peninsula, and is of little importance. The point of land extending into the bay at Fish Creek is largely occupied by this soil. Another small area occurs along the shore in sec. 34, Sturgeon Bay Town, and in sec. 3, Claybanks Town. The surface is level to undulating. The soil represents a beach formation consisting of material washed up on the shore by the waves. No effort has been made to grow crops on this soil, and it may be classed as nonagricultural.

CHAPTER VI.

GENERAL AGRICULTURE AND CLIMATE.

AGRICULTURE.

The first white settler in Door County located on Little Sturgeon Point in 1835. Agricultural development, however, did not begin until 1852–1855, when a settlement of Moravians was made at Ephraim and a large number of Belgians settled at Brussels, in the southern part of the county. The entire county was originally covered with a dense stand of timber, which was removed long ago. The early agriculture consisted mainly of grain production, with the growing of enough vegetables and fruit to supply the family. As was the case in nearly every other section of Wisconsin, wheat was at first the principal crop. Until about 1900 the wheat acreage was larger than that of any other cereal. From 1880 to 1900 over 200,000 bushels of wheat were produced annually. Wheat growing proved profitable for a long periol, but gradually, owing to poor cultivation, lack of fertilization, and continued cropping without any attempt to follow a systematic rotation, the soils produced such poor yields that some other line of farming had to be introduced. In 1909 only 3,474 acres of wheat were grown and 52,070 bushels produced, as compared with 16,616 acres seeded and a production of 239,000 bushels in 1899. Wheat production gradually gave way to a more diversified system of farming. Hay, oats, barley, rye, corn, and potatoes proved profitable crops, and dairying was begun. Fruit growing was taken up in place of wheat production. The principal field crops grown at present, named in order of acreage, are hay, oats, rye, barley, wheat, peas, potatoes, corn, flax, and buckwheat.

The total area devoted to tame hay in 1909 was 32,750 acres, from which 42,581 tons were obtained. About two-thirds of this consisted of clover and timothy mixed, about one-fifth timothy

alone, and one-tenth of clover alone. Very little alfalfa is grown, although over much of the county the soils are well adapted to this valuable legume. Only small quantities of marsh hay are cut. Most of the hay produced is fed to stock, but some farmers sell part of the crop each year.

Since the decline in wheat production, oats have been the leading small grain crop. In 1909 oats occupied 16,812 acres, on which 492,382 bushels were produced, or about 30 bushels per acre. The crop is well adapted to the soils of the county, and every farmer grows it. Some of the crop is sold, but the greater part is fed to stock on the farm.

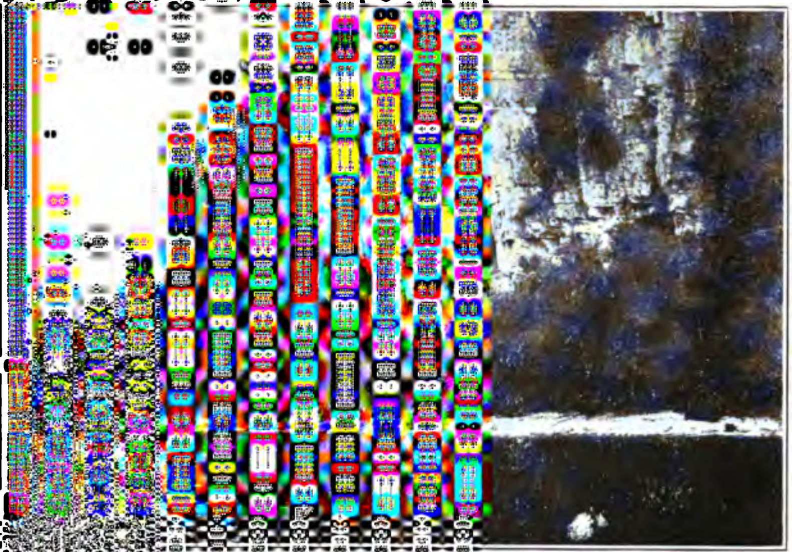
Next to oats rye is the most important grain. In 1909 there were 8,468 acres in this crop, producing 130,260 bushels, or 15.4 bushels per acre. Barley is grown quite extensively. In 1909, a production of 128,166 bushels was obtained from 5,272 acres, the yield averaging about 25 bushels per acre. Considerable income is derived from the sale of barley, but part of the crop is fed on the farms. Wheat, while it has declined greatly in importance in the last 15 years, is still grown to some extent. In 1909 the crop was grown on 3,474 acres and produced 52,070 bushels, an average of 15 bushels per acre. Since that year, however, the growing of wheat has become less important.

Potatoes produce fairly good yields on most of the soils. The 1910 census shows a production of 225,391 bushels from 2,273 acres, and average yield of about 100 bushels per acre. Potatoes are grown mostly for home use.

Corn is not grown very extensively at present, but the acreage is being increased each year. In 1909 only 1,417 acres of corn were grown in the entire county, but since that year the growth of the dairy industry and the building of silos have led farmers to devote more land to the crop. The soils in that part of the county north of Sturgeon Bay are better adapted to the growing of corn than is the heavy clay soil in the southern part. Corn does not always mature, but it never fails to reach the stage where it makes good silage. Certain early maturing varieties, recently produced through scientific selection and breeding, have been grown with much success.

The growing of peas for canning was for a time an important industry in the vicinity of Sturgeon Bay. Two large canning

Plate III.



[illegible] N BAY IN PENINSULA [illegible]

[illegible] es situated on the Green Bay [illegible] geon Bay, and between the vil- [illegible] ted for its scenic beauty and [illegible] on.

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[illegible] OOR COUNTY.

[illegible] 25 miles of water bound ma- [illegible] has added materially to this [illegible] ilding material immediately at [illegible] ere much less than in many

plants, one at Sturgeon Bay and the other at Sawyer, handled the peas grown on a large acreage. In 1913 the output of the cannery at Sturgeon Bay was 3,000,000 cans. The census reports a total of 21,845 acres devoted to peas in 1909, producing 307,739 bushels. In the past few years the pea canning industry has rapidly declined, owing chiefly to diseases of this crop.

Trucking has been developed quite extensively in conjunction with fruit growing, especially in the vicinity of Sturgeon Bay. For several years while the fruit trees are growing and even after they have come into bearing there is considerable cultivable land between the rows of trees, and this is utilized for the growing of truck crops. Strawberries and blackberries raspberries are grown to a considerable extent, and vegetables are produced in quite large quantities. The 1910 census reports 101 acres in small fruits, of which strawberries alone occupied 72 acres.

Aside from fruit growing, dairying is the most important specialized industry. Dairy farming is developed most extensively in the southern part of the county on the heavy clay soils, but it is growing in importance each year even in the fruit districts. Quite a number of orchardists keep a dairy herd and find the combination of fruit growing and dairying very satisfactory, as it distributes the labor over the entire year and insures some income in case the fruit crop is a failure. The soils in the southern part of the county are very well adapted to dairying, as they produce good crops of hay and corn and supply good pasturage. The Superior soils are natural grass soils, producing heavy yields of hay and furnishing excellent pasturage. Perhaps the most thriving dairying community is the so-called Belgian settlement in the vicinity of Brussels. There are a number of fine pure-bred dairy herds in the county. Holstein and Guernsey are the most popular breeds. Most of the dairy animals are of grade or scrub stock, but the type is rapidly being improved by the use of pure-bred sires. There are 55 cheese factories and 15 creameries in Door County. Most of the cheese factories are in the southern part of the county, but the section north of Sturgeon Bay is rapidly developing in dairying, and more cheese factories are being built each year. There is a condensary in Sturgeon Bay which receives from 50,000 to 60,000 pounds of milk daily.

The raising of beef cattle receives little attention in Door County, although there are numerous steep and rocky areas which are better suited for grazing than for general farming. Only a few farmers make a specialty of raising beef breeds, and most of the stock sold for slaughtering consists of mixed types. Many calves, the surplus of the dairies, are sold for veal. The horses throughout the county, notably in the Belgian settlement at Brussels, show more careful breeding than do the cattle. Heavy draft horses are common. Many colts are raised each year, and farmers frequently have a team to sell. In 1909 there were 7,405 sheep in the county. Sheep raising has never been important, but it will probably increase in the future. Hog raising is carried on in conjunction with dairying. Practically all the farmers produce enough pork for their own use and many have considerable income from the sale of hogs.

The common crops are grown promiscuously on nearly all the soils of the county. The predominant soil in the southern part is the Superior loam, rolling phase, while in the northern two-thirds the Miami loam predominates. On the heavy Superior soils hay, corn, and small grains for feeding dairy cows are grown. These soils are well adapted to such crops. The soils in the southern part of the county are in general very well adapted to dairying, but not to fruit growing. The fruit industry is confined largely to the Miami loam, which is very well adapted to orcharding in both texture and topography. More attention has been given to soil adaptation in fruit growing than in connection with other crops.

Only a few farmers study the question of crop rotations and follow a fixed rotation from year to year. The same rotations are followed on nearly all the soils, regardless of their suitability. A rotation well suited to most of the soils consists of one or two years of small grain, with which grass seed is sown. Hay is cut for one or two years, after which the sod is plowed up and a cultivated crop like corn or potatoes planted. If desired the field may be pastured for one year while it is in grass, thereby increasing the length of the rotation. On the Superior soils it is advisable to keep the land in hay longer than on the Miami soils.

The methods of cultivation followed are not in all cases those best suited to the needs of the soil. This is especially true

on the Superior clay loams. Poor drainage keeps the soil wet until late in the spring, and in many cases the fields must be cultivated before the soil is dry enough to work up properly. This frequently leads to puddling of the soil, which requires considerable time and labor to correct. Fall plowing is done in most cases and gives good results, as the alternate freezing and thawing in the winter and spring breaks up the lumps and kills weed seeds and numerous insect and fungous pests. The stable manure produced is in general carefully preserved and put back on the land. The tendency is to cultivate the orchards with more care than the land used for other crops. On most of the larger orchards up-to-date machinery is used for cultivation.

Three noxious weeds are very abundant and troublesome in Door County. The Canada thistle is the most common. Many fields are completely overrun with this pest, and others are overrun with wild mustard. Quack grass is very troublesome in places. These weeds are quite difficult to eradicate, but they can be gotten rid of even where most abundant.[1]

The farm buildings throughout the county as a rule are substantial and in good repair. On many of the dairy farms good silos are in use, and more are being built yearly. In the extremely stony sections stone fences are common. In the southern part of the county and in areas where stones are less numerous the fields are well fenced with barbed or woven wire.

The supply of hired help for the farm is usually insufficient, and outside the fruit-growing sections members of the family do most of the work except during extremely busy seasons. In the fruit sections large numbers of workers, including boys and girls of all ages, are brought in from outside cities during the picking season. They are paid by the amount of fruit picked.

The 1910 census reports 2,310 farms in Door County, with an average size of 109 acres. Over 84 per cent of the land in the county is in farms, and 53.4 per cent of this land is improved, giving each farm an average of 58 acres of improved land. Practically all the farms are operated by the owners. Only 3 per cent are leased to tenants, and less than 1 per cent are operated by a hired manager. It is the custom of the large orchard owners to engage skilled managers.

[1] See Bul. Wis. Agr. Expt. Sta., Eradication of weeds.

The price of farm lands depends largely upon the type of soil, the quantity of stone present, and the location. The highest-priced land in the county is in the fruit-growing section. In the northern end of the county, where most of the soil is shallow and stony, improved land can be purchased for $50 to $75 an acre. Farms on the Kewaunee loam not too far from the railroad are valued at $100 or more an acre. Farms on the sandy soils sell for $20 to $40 an acre. The 1910 census gives the average assessed value of land in Door County as $37.90 an acre. Since that year, however, the average value has greatly increased. Cherry orchards in full bearing and in good condition sell for $400 to $600 an acre. Cherry trees produce their maximum yields when 10 to 20 years of age. Orchards which have not reached the full-bearing stage—that is, orchards about 5 or 6 years old, sell for $300 to $400 an acre, and young orchards about 2 years old for $250 to $300 an acre. These prices are the average for cherry orchards in the vicinity of Sturgeon Bay. In the northern end of the peninsula the selling price is about $100 less an acre for each class of cherry orchards.

FRUIT GROWING.

Fruit growing in Door County really began in 1983 when 10 acres of plums were set out near Sturgeon Bay. In 1896, 3 acres of cherries were set out. During the next 10 or 15 years farmers in the vicinity of Sturgeon Bay and in other parts of the county made considerable plantings of cherrries, apples, plums, and small fruit. Immense crops of excellent strawberries were produced. Until 1910 no very large plantings of cherries had been made, only a few orchards being more than 10 acres in extent. In the spring of 1910 one company set out 40 acres of cherries and 20 acres of apples. During the winter of 1911 many stock companies were organized and in the spring thousands of cherry, apple, and plum trees were planted. One company alone set out 200 acres of cherry trees, which have since been increased to 700 acres. This is, as far as known, the largest orchard of sour cherries in the world.

* For more detailed information on the planting and management of orchards, see Buls. No. 201, 207, 269, Wis. Agr. Expt. Sta. Also reports of the Wisconsin Horticultural Society.

During 1912 and 1913 planting was caried on to an even greater extent, not only at Sturgeon Bay but also at many other points along the Green Bay side of the peninsula. At the present time the acreage in fruit is estimated at 3,500 acres of cherries, 1,700 acres of apples, and 200 acres of plums. Besides this a considerable acreage is devoted to strawberries, currants, raspberries, and other small fruits.

The Richmond and Montmorency are practically the only varieties of cherries grown. The apples grown most extensively on a commercial scale are the Wealthy, Oldenburg, Fameuse, McIntosh, Dudley, Northwestern, Tolman, and McMahon. Some other varieties have been tried. The chief varieties of plums grown are the Burbank, Lombard, Gueii, and Bradshaw.

Some grapes are produced in different parts of the county. The varieties grown are Campbell, Moore, and Norton.

Door County is so well adapted to the growing of fruit, especially cherries, largely on account of its favorable climate and soils. The Miami loam, on which most of the fruit is grown, is a mellow loam soil ranging from 1 to about 4 feet in depth, overlying limestone rock. Cherry trees have a peculiar ability to take root and flourish on very shallow soil, and in numerous cases trees planted in soil so shallow that holes had to be blasted in the rock have made splendid growth and produced heavy yields. The roots penetrate the seams and crevices and apparently obtain moisture and plant food from the very rock. The rolling topography induces good drainage, without which cherry trees can not grow well.

The climate of Door County is extremely well adapted to fruit growing. The waters of Lake Michigan and Green Bay delay the occurrence of frosts in the fall, permitting the fruit to ripen, the buds to develop, and the new growth to mature while the foliage is still on the tree. In the spring the cold winds from these waters retard blossoming until danger from frost is past. The summers are cool, with comparatively little change in temperature from day to night, also a condition favoring the proper development of the fruit. On the Green Bay side of the peninsula the season is on the average about two weeks earlier than on the Lake Michigan side, owing to the fact that the waters of Green Bay warm up quicker in the

spring than the waters of Lake Michigan. Cherries and other fruits grown on the Green Bay side of the county ripen and can be put on the market two weeks earlier than fruit grown on the lake side. For this reason cherry growing is confined largely to the west side of the peninsula. In the fall, however, the killing frosts occur earlier on the Green Bay side, owing to the fact that the lake cools more slowly.

The principal problem which confronts the cherry grower is to get the labor to care for the orchard and to pick the fruit. An orchard to be profitable requires careful plowing and cultivating and regular spraying, and the fruit must be picked as soon as it ripens. On the average it takes five good pickers per acre for a mature orchard in a good season. Some of the larger orchard owners bring in a large number of pickers from Milwaukee, Chicago, and other cities each season. The pickers are housed in buildings or tents erected on the grounds. For the last few years a summer Y. M. C. A. camp has been maintained at Sturgeon Bay during the cherry-picking season. This camp furnishes a large number of pickers. In the immediate vicinity of Sturgeon Bay children and other persons out of employment are engaged to pick cherries. The farther the fruit grower is from Sturgeon Bay the more difficult it is to obtain competent help. Each season more and more pickers will be needed, as only a small proportion of the trees planted have reached maturity. Since the spring of 1913 no extensive plantings have been made except the replacing of trees that have grown too old or have died. The average life of a cherry tree is about 20 years. Even if no more trees are set out it is probable that the present acreage is all that can be cared for when the trees mature. All the trees now growing will not reach maturity, as some orchards are planted on soil unfit for cherry culture, where the subsoil may be too heavy, the topography too level, and the drainage deficient. Some orchards have been greatly injured or even ruined by improper care or poor methods of cultivation. Spraying, which yearly becomes more important with increase in fungous diseases and insect pests, is sometimes neglected.

The first step toward solving the problem of marketing cherries and other fruits so as to obtain the highest prices was taken in 1910, with the organization of the Door County Fruit

Exchange. This organization sells all the fruit collectively and does away with local competition. This has recently been reorganized into the Door County Fruit Growers' Union. This organization also has a canning factory for fruits of all kinds. The business is handled by a manager elected by the board of directors. The highest market prices are received and the results obtained are much more satisfactory than before organized marketing existed. Most of the cherries are marketed in Minneapolis, St. Paul, Duluth, and other cities of the Northwest.

In the future the acreage devoted to apple will undoubtedly increase. Apples are not nearly so perishable as cherries, they do not require so many pickers per acres, and are not necessarily marketed immediately after being gathered as is the case with cherries. The life of an apple tree is considerably longer than that of a cherry tree. Door County is situated near good markets, such as Chicago, Milwaukee, and the Twin Cities and can successfully compete with western apples.

Clean, thorough cultivation is essential in cherry growing. The orchards are cultivated at regular intervals until about the 10th of July. In young orchards a cover crop is sown in the late summer or early fall. This serves as a protection during the winter and when plowed under in the spring it increases the supply of organic matter in the soil. In young orchards various cultivated crops are sometimes grown between the rows of trees. The soil would require thorough cultivation even if no crops were grown and this use of the land gives the owner a source of income before the orchard comes into bearing. Potatoes, beans, and strawberries are the crops usually grown in orchards. In old orchards no cover crop is ordinarily grown, weeds being allowed to grow up after cultivation is over for the season. The mature orchards are not plowed each year as are the young orchards, but are first worked with a disk harrow and cultivated during the season with some other harrow or cultivator. Most of the growers practice hoeing around the trees where the harrow can not be used. This not only kills the weeds but also covers up the old, fallen leaves in which are harbored fungous and other diseases.

Up to the present time the only fertilizer used in cherry growing has been stable manure. Best results have been obtained by applying manure yearly around the trees to cover

an area somewhat larger than the spreading branches. With young trees just coming into bearing there is danger of manuring too heavily, as heavy applications of fertilizer high in nitrogen may produce tree growth instead of fruit. It is probable that commercial fertilizers will have to be resorted to before long.

Spraying is recognized as a necessity in orcharding. To be effective, spraying must be done thoroughly at the proper time, and with the proper materials. The three most common cherry pests are the shot-hole fungus, the brown rot, and the black aphis. The most common pests of the apple are the codling moth, aphis, scab, oyster-shell scale, and fire blight.

"In the earlier days of cherry culture, when the life history of the shothole fungus was not fully known, its ravages ruined some orchards. Recently it has been shown that it overwinters on the fallen leaves, and with this understanding the burying of the leaves by early spring culture combined with a revised spraying program has given adequate control".*

The care and management of apple and plum trees is practically the same as that for cherry trees, except that the time of spraying and the kind of spray materials vary, with difference in the fungus and insect pests.

* From statement of Prof. L. R. Jones, Division of Plant Pathology, University of Wisconsin. This Division is constantly studying and investigating various plant diseases and pests which do injury to farm, garden and orchard crops. New programs for spraying, and improved methods of fighting these pests are being worked out. For special information concerning plant diseases, insect pests, and how to combat them, those interested should write the Wisconsin Agricultural Experiment Station, Madison, Wis.

CLIMATE.

The climate of Door County is milder on the Green Bay side of the peninsula than on the Lake Michigan side. This is due to the fact that the lake being a much larger body of water is influenced much more slowly by the seasonal changes in temperature than are the waters of Green Bay. As the waters of the Bay warm up earlier in the season, and also reach a higher temperature than the waters of the lake, the land bordering these respective bodies of water is influenced accordingly.

The average annual precipitation for Door County is a little over 31 inches. The greater part of the precipitation comes during the growing season, when most needed. During each of the six months from April to September, inclusive, the mean rainfall reaches 2.5 inches or more. There are times, however, during nearly every season when crops suffer from lack of moisture.

The Weather Bureau Station at Sturgeon Bay is located on the Ship Canal near Lake Michigan, and but little above the level of the lake As the following records were secured from this station they represent only the condition which prevails along the Lake Michigan shore. Observations over a number of years, and the practical farming experience of the region indicates that the growing season on the Green Bay side of the peninsula is approximately two weeks longer than on the lake side.

The mean temperature for the three winter months as recorded at Sturgeon Bay is 20.4° F. and for the months of June, July, and August, 63.9° F. The average date of the first killing frost in the fall as recorded at Sturgeon Bay for the seven-year period 1909 to 1915, inclusive, is October 2 and that of the last in the spring May 25, giving the region in the immediate vicinity of the Weather Bureau Station an average growing season of 129 days. This is practically as long as the growing season at North Yakima, Wash., and Hamilton, Mont., the centers of the two leading fruit districts of the West.

The favorable climate of Door County is the principal factor in making it such an important fruit growing district. The winters are milder than in regions farther south removed from lake influences, they are freer from prolonged cold snaps, and the snow which covers the ground almost continually from De-

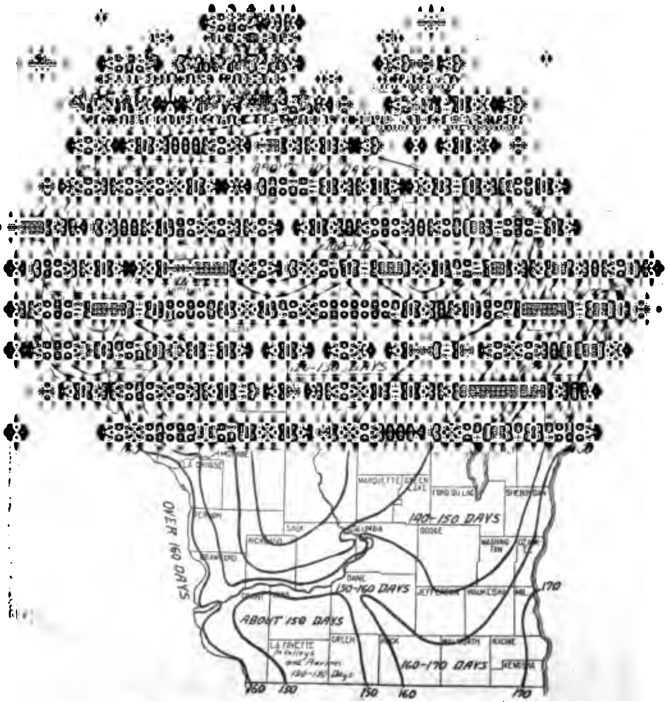

Fig. 2.—Map showing length of growing season for corn.

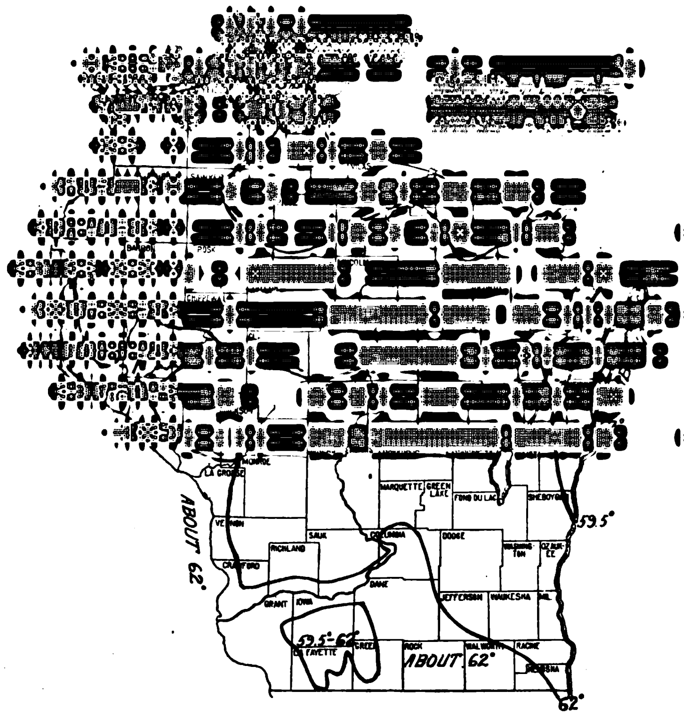

Fig. 3.—Map showing average temperature for the six growing months April to September, inclusive. Note that the difference between the average temperature for the area surveyed, and the southern portion of the State is only slight.

cember 1 to April 1 prevents deep freezing of the soil. There is an absence of the extremes in temperature which permit of alternate freezing and thawing in the winter. The cool waters of Lake Michigan and Green Bay cause late springs, which retard blossoming until the danger from frost is passed. The summers are cool and clear, with a comparatively uniform temperature from beginning to end, so that the fruit develops properly and produces good quality and color. In the fall the surrounding water, being warm from the summer's heat, prolongs the season and wards off early frost, enabling the fruit buds to develop properly and the new growth to mature.

In the following table are shown the normal monthly, seasonal, and annual temperature as recorded at Sturgeon Bay, and the normal and extreme monthly, seasonal, and annual temperature and precipitation as recorded at Green Bay:

Temperature and precipitation at Sturgeon Bay and Green Bay.

Month.	Temperature.				Precipitation at Green Bay.		
	At Sturgeon Bay	At Green Bay.					
	Mean.	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	24.7	21.3	52	—21	1.81	1.78	0.99
January	18.7	14.6	51	36	1.69	1.96	.91
February	17.9	17.2	59	—33	1.60	.74	.83
Winter	20.4	17.7	59	—36	5.10	4.48	2.73
March	26.6	26.8	82	—23	2.40	.41	.87
April	39.7	40.7	84	11	2.44	1.21	2.75
May	49.0	54.5	91	26	3.57	4.28	4.42
Spring	38.4	40.7	91	—23	8.41	5.90	8.04
June	60.4	65.1	100	34	3.55	2.37	8.68
July	65.7	69.5	100	43	3.51	1.44	4.95
August	65.7	67.0	98	40	3.10	3.71	5.25
Summer	63.9	67.2	100	34	10.16	7.52	18.89
September	59.5	59.1	95	25	3.12	1.24	4.86
October	47.6	47.1	84	8	2.37	.40	1.73
November	34.7	32.5	69	-12	1.96	1.50	1.78
Fall	47.3	46.2	95	-12	7.45	3.14	8.37
Year	42.6	43.0	100	—36	31.12	21.04	38.03

SUMMARY.

Door County is situated in the eastern part of Wisconsin, on Lake Michigan. It lies within the glaciated-limestone region and its surface varies from undulating to gently rolling. Over much of its area the soils are shallow and quite stony. Its total area, including Washington and Chambers Islands, is 469 square miles or 300,160 acres.

The first permanent settlements in Door County were made about 1852. The county was originally heavily wooded, and for a long period lumbering was the chief industry. Nearly all the desirable land in the county is now in farms, and much of the soil is under cultivation.

The population, 1910, was 18,711. Sturgeon Bay, the county seat, had, in that year, a population of 4,262.

There are only about 15 miles of railroad in the county, but good wagon roads and automobile stage lines reach all sections.

The Late Wisconsin drift is the surface formation covering Door County. The bedrock is Niagara limestone. The red clay extensively developed in the southern part of the county is of lacustrine origin, but since its deposition has been modified more or less by glacial action.

Excluding Rough stony land, Peat, Much, and Beach sand, 6 soil series are recognized in the county.

The Miami series consists of light-colored, timbered upland soils derived from glacial limestone material. This is the most extensive and important series in the county. The loam is the predominating type, and it is on this soil that most of the cherries are grown. The silt loam is well adapted to general farming, and dairying is becoming an important industry.

The Superior series is derived from both lake-laid and ice-laid material, and is characterized by having heavy, red clay in either the surface soil or subsoil. The loam is the predominating type, but there is also considerable acreage of the clay loam and fine sandy loam. The soils of this series make an excellent general farming land, well adapted to dairying.

The Poygan loam is closely associated with the Kewaunee and Superior soils and is of the same origin, but it has a black surface soil with a red clay subsoil. It occupies low, wet, and poorly drained areas where there has been a large accumulation of organic matter.

The Clyde series consists of black soils of alluvial or lacustrine origin occupying old lake beds, ponded valleys, or first-bottom areas along the streams. These soils are low and poorly drained, but they are very productive and give good yields when drained and improved.

The Fox series includes light-colored soils in glaciated-limestone regions occupying outwash plains or stream terraces. The series is not very extensive in this county.

The Plainfield sand and fine sand are of small extent and of little importance. They are light-colored soils of alluvial origin, derived largely from sandstone formations. They are loose and open, and droughty during at least a part of each growing season.

Peat occurs in numerous areas of varying size in different parts of the county. It consists of vegetable matter in various stages of decomposition, with small amounts of mineral matter. At present most of this land is wet and undrained and of no agricultural use whatever, but much of it can be drained and made into valuable land.

Muck includes highly organic soils intermediate between Peat and the Clyde soils. It is not very extensive in Door County.

Beach sand consists of material which has been washed on shore by the waves and blown by the wind so as to have a broken, bumpy topography. Much of it is shifting sand dunes, and it is of little value.

Rough stony land comprises steep, rocky slopes or rock outcrops where the land is too broken or the soil too shallow and stony for cultivation.

The agriculture of Door County embraces fruit growing, dairying, and the production of general fruit, canning, and truck crops. The cherry is the fruit most extensively produced. The climate and soil are apparently ideal for this fruit, and over 3,500 acres have been set in orchards. The apple also thrives.

The climate of Door County is favorable for general farming dairying, and fruit growing. The mean annual temperature is about 43° F., the mean annual precipitation about 31 inches, and the average length of the growing season about 129 days. The waters of Green Bay and Lake Michigan stabilize frost occurrence and make conditions ideal, in this respect, for fruit growing.

The length of growing season as here indicated is based upon temperature records taken at the station on the Canal near the Lake Michigan shore, where the influence of Lake Michigan is very pronounced. The growing season on the Green Bay side of the peninsula is approximately two weeks longer than it is on the Lake Michigan side.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep a map permanently. It the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.